PRODUCTION OF FRESH WATER FROM SEA WATER

HEARINGS

BEFORE THE

SUBCOMMITTEE ON IRRIGATION AND RECLAMATION

OF THE

COMMITTEE ON INTERIOR AND INSULAR AFFAIRS HOUSE OF REPRESENTATIVES

EIGHTY-SECOND CONGRESS

SECOND SESSION

ON

H. R. 6, H. R. 7, H. R. 6578, H. R. 6704, and H. R. 7185

TO PROVIDE FOR RESEARCH INTO AND DEMONSTRATION OF PRACTICAL MEANS FOR THE ECONOMICAL PRODUCTION, FROM SEA OR OTHER SALINE WATERS, OF WATER SUITABLE FOR AGRICULTURAL, INDUSTRIAL, MUNICIPAL, AND OTHER BENEFICIAL CONSUMPTIVE USES, AND FOR OTHER PURPOSES

JUNE 19, 20, 22, 1951, AND MARCH 11, 1952

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JAMES K. CARR, *Consultant on Irrigation and Reclamation*

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PRODUCTION OF FRESH WATER FROM SEA WATER

TUESDAY, JUNE 19, 1951

HOUSE OF REPRESENTATIVES, SUBCOMMITTEE ON
IRRIGATION AND RECLAMATION OF THE COMMITTEE
ON INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The subcommittee met at 10 a.m., the Honorable Clair Engle presiding.

Mr. ENGLE. The Subcommittee on Irrigation and Reclamation will be in order for the consideration of H. R. 7, introduced by Representative McKinnon, and H. R. 6, introduced by Representative Phillips.

These are identical bills and are identical to S. 5 from the other body.

(The bills referred to are as follows:)

[H. R. 6, 82d, Cong., 1st sess.]

A BILL To provide for research into and demonstration of practical means for the economical production, from sea or other saline waters or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of economically feasible means of producing from sea water, from other saline waters, or from the atmosphere (including cloud formations) water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized to construct, maintain, and operate facilities (including not more than one demonstration plant) to determine and to demonstrate the feasibility of producing water as aforesaid and for purifying, storing, transporting, and distributing the water and byproducts derived from the operation of such facilities. Facilities constructed and operations undertaken pursuant to this Act shall be on a scale sufficient to determine the feasibility of the development of such production, transportation, and distribution, on a large-scale basis, for the purpose of conserving and increasing the water resources of the Nation.

SEC. 2. In order to carry out the purposes of this Act, the Secretary of the Interior is authorized—

(a) to conduct research and development work, and with the demonstration plant and other facilities to make careful engineering studies to ascertain the lowest investment and operating costs, and to determine the best plant designs and conditions of operation;

(b) to study methods for the recovery and marketing of byproducts resulting from and incident to the production of water as herein provided for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

(c) to acquire, by purchase, license, lease, or donation, secret processes, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

(d) to engage, by contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work;

(e) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act;

(f) to request other Federal departments, agencies, and instrumentalities to provide assistance in carrying out his functions under this Act, which assistance such departments, agencies, and instrumentalities are hereby authorized to render, and to advance to them funds required to render such assistance or to reimburse them for costs incurred in so doing; and

(g) to pursue on the ground or, any provision of law or administrative regulation to the contrary notwithstanding, in the air operations for producing water from the atmosphere (including cloud formations).

SEC. 3. The Secretary of the Interior is authorized to dispose of all water and other products produced as a result of its operations under this Act pursuant to regulations to be prescribed by him: *Provided*. That any runoff resulting from precipitation created artificially under the authority granted in this Act shall be considered as a part of the natural stream flow and shall be available for use in the same manner as other natural accretions to the stream flow; and the Secretary shall have authority to grant, under such terms as he may consider appropriate, licenses under patent rights acquired under this Act: *Provided*, That such licenses are consistent with the terms of the agreements by which such patent rights are acquired. No patent acquired by the United States, under this Act shall prevent any citizen of the United States, or corporation created under the laws of the United States or any State thereof, from using any invention, discovery, or process covered by such patent, or restrict such use by any such citizen or corporation, or be the basis of any claim against any such person or corporation on account of such use.

SEC. 4. All moneys received for products of the plants and for royalties and licenses under this Act shall be paid into the Treasury as miscellaneous receipts.

SEC. 5. The acts and omissions of any person or corporation who, in accordance with the terms of a contract with the United States entered into under the provisions of this Act, carries on operations for the artificial inducement of precipitation shall, with respect to third parties who are or may be adversely affected by precipitation so induced or by other meteorological phenomena caused by such inducement or attempts thereat, be deemed the acts and omissions of the United States and shall be governed by the law applicable to the same, and the Secretary of the Interior is hereby authorized to provide in any such contract that the United States shall indemnify the contractor against liability on account of claims (including reasonable expenses of litigation and, when approved in advance by the Secretary, compromise or settlement of such claims) made by third parties as hereinbefore described and any contract so providing shall also contain appropriate provisions for notice to the Government of suits or actions filed, or claims made, against the contractor with respect to any alleged liability to which the indemnification provisions relate and for control of or assistance in the defense of any such suit, action, or claim by the Government at its election.

SEC. 6. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The reports shall include suitable recommendations for further legislation.

SEC. 7. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.

SEC. 8. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $25,000,000, as the Congress may from time to time deem necessary to carry out the provisions of this Act.

[H. R. 7, 82d Cong., 2d sess.]

A BILL To provide for research into and demonstration of practical means for the economical production from sea or other saline waters or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground

waters throughout the Nation, it is the policy of the Congress to provide for the development of economically feasible means of producing from sea water, from other saline waters, or from the atmosphere (including cloud formations) water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized to construct, maintain, and operate facilities (including not more than one demonstration plant) to determine and to demonstrate the feasibility of producing water as aforesaid and for purifying, storing, transporting, and distributing the water and byproducts derived from the operation of such facilities. Facilities constructed and operations undertaken pursuant to this Act shall be on a scale sufficient to determine the feasibility of the development of such production, transportation, and distribution, on a large-scale basis, for the purpose of conserving and increasing the water resources of the Nation.

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(b) to study methods for the recovery and marketing of byproducts resulting from and incident to the production of water as herein provided for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

(c) to acquire, by purchase, license, lease, or donation, secret processes, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

(d) to engage, by contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work;

(e) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act;

(f) to request other Federal departments, agencies, and instrumentalities to provide assistance in carrying out his functions under this Act, which assistance such departments, agencies, and instrumentalities are hereby authorized to render, and to advance to them funds required to render such assistance or to reimburse them for costs incurred in so doing; and

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SEC. 4. All moneys received for products of the plants and for royalties and licenses under this Act shall be paid into the Treasury as miscellaneous receipts.

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precipitation so induced or by other meteorological phenomena caused by such inducement or attempts thereat, be deemed the acts and omissions of the United States and shall be governed by the law applicable to the same, and the Secretary of the Interior is hereby authorized to provide in any such contract that the United States shall indemnify the contractor against liability on account of claims (including reasonable expenses of litigation and, when approved in advance by the Secretary, compromise or settlement of such claims) made by third parties as hereinbefore described and any contract so providing shall also contain appropriate provisions for notice to the Government of suits or actions filed, or claims made, against the contractor with respect to any alleged liability to which the idemnification provisions relate and for control of or assistance in the defense of any such suit, action, or claim by the Government at its election.

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[H. R. 6578, 82d Cong., 1st sess.]

A BILL To provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

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(b) to engage, by contract, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work; to coordinate the study of methods for the recovery and marketing of byproducts resulting from and incident to the production of water as herein provided for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

(c) to acquire, by purchase, license, lease, or donation, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided,* That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

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[H. R. 6704, 82d Cong., 2d sess.]

A BILL To provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

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(c) to acquire, by purchase, license, lease, or donation, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

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SEC. 7. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $20,000,000, as the Congress may from time to time deem necessary to carry out the provisions of this Act.

[H. R. 7185, 82d Cong., 2d sess.]

A BILL To provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

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REPORT FROM THE SECRETARY OF THE INTERIOR ON H. R. 6 AND H. R. 7, DATED APRIL 10, 1951

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., April 10, 1951.

Hon. JOHN R. MURDOCK,
Chairman, Committee on Interior and Insular Affairs,
House of Representatives, Washington, D. C.

MY DEAR MR. MURDOCK: I am glad to comply with your requests for an expression of the views of this Department on two identical bills (H. R. 6 and H. R. 7) to provide for research into the demonstration of practical means for the economical production, from sea or other saline waters or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

H. R. 6 and H. R. 7 are based upon several previous bills and amendments thereto. These include S. 1300 and H. R. 3123, Eighty-first Congress, which were introduced by Senator O'Mahoney and Congressman McKinnon, respectively; the amendments to S. 1300 proposed on January 5, 1950, by Senator Downey for himself and Senators O'Mahoney and McFarland, and the amendments recommended by this Department in its reports of July 7, 1949, April 12, 1950, and June 23, 1950, to the Senate Committee on Interior and Insular Affairs and in its report of April 12, 1950, to the House Committee on Public Lands. Reference is invited to those reports for certain details not herein discussed.

Enactment of H. R. 6 or H. R. 7 would authorize this Department to engage in necessary research to develop economically feasible means of producing from saline waters directly or from the atmosphere water which is suitable for beneficial consumptive use.

Water shortages are acute throughout many areas of the West today, where many thousands of acres of irrigated land are being kept in production only through serious overpumping of the existing ground water. Pumping from ground water for irrigation in some of the most highly productive areas in Califor-

nia, Arizona, and New Mexico, during the past few years has been at rates far exceeding the safe yields as estimated by the United States Geological Survey.

Thousands of acres of fertile western soil await only irrigation water to be transformed into highly productive agricultural lands. With ample water for these lands, opportunities would be presented for expansion of our traditional American farm family way of life, and production of crops to feed and clothe our growing population would be greatly increased.

The fears of drought with its devastation of farm capital and income and its repercussions in commerce and taxation could be ameliorated and perhaps removed all over the United States with discovery of successful ways to obtain precipitation when and where it is needed.

Rapid increases in population in the Los Angeles, San Diego, and San Francisco-Oakland metropolitan areas of California, during the 1940's and prospective increases there during the 1950's require an ever-continuing search for water. If the present emergency continues for long, the need for additional domestic and industrial water supplies in these and some of the other western cities may well become immediate and pressing.

Many eastern cities, including New York City, Norfolk, Baltimore, Philadelphia, St. Petersburg, Tampa, Mobile, and New Orleans, as well as midwestern and western cities, are vulnerable to droughts; and sudden increase in the population or industry, such as that which would result from defense preparations or war, would cause serious water shortages in many areas.

Many areas throughout the Western States, because of soil characteristics, have water which is too salty, either originally or because of use and reuse, to be used for irrigation or for industrial and even domestic purposes. Such saltiness is minor compared with the concentrations of ocean water. Such problems can at times be corrected by dilution of the water, or by leaching of soils. But to do so requires an abundance of fresh water generally not available for such purposes.

Man's search for water is the history of the world. The Bible is full of the importance of water to the tribes of Israel. Egypt rose and fell on the flow of the Nile. The Great Plains area of the United States rose to a peak, then came a disastrous slump from lack of water. Man has relied upon wells and the wells dried up; he has tried rivers, and the rivers dried up. Lakes and springs come and go with weather conditions. Few people realize the importance of water in their everyday lives. Water appears to be but an accomplished fact to the average person. But it becomes a fact only as the result of work, research, and vision.

The bills before you are a step forward in man's search. It is a visionary step.

The benefits to millions of our citizens that would follow successful development of economically feasible means of producing, from the oceans and other saline waters, water of quality suitable for beneficial consumptive use would be incalculable. The large-scale purification of the salt water of oceans, either directly in conversion plants or by inducing precipitation of the moisture that nature herself has evaporated from the seas and transported inland, is an opportunity that challenges not only the imagination but the scientific resources of the Nation as well. Frontiers would be opened for development throughout the United States.

Converting salt water to fresh water is an everyday occurrence. Any schoolboy can do it with a teakettle. The problem is how to do it on a large scale at reasonable cost. Already we know that by compression-distillation methods fresh water can be and is being produced for a cost of near $180 per acre-foot. The limiting factor is energy cost. Perhaps use of solar energy is the answer. Numerous other methods have been and should be studied. Some already give promise of water at a reasonable price.

Evidence is also piling up that points to the conclusion that it is possible, under certain conditions not completely defined as yet, to cause some rainfall or snowfall artificially. However, the purpose of governmental research to date has been confined almost entirely to the study of cloud modification. Except for very meager studies by private firms, practical rain-making to increase water supplies has not been an objective of research. I say this notwithstanding the fact that very large segments of our Western States are now undergoing commercial cloud-seeding operations based on very scanty knowledge of the consequences.

From present indications, it appears that the cost of producing rain or snow artificially may be remarkably low once the research and experimental work has been completed. It appears possible that the winter snow pack in certain mountainous areas might be increased in this way. Thus the total quantity of water available for irrigation, municipal water supply, and power production would also be increased. Much basic and applied research and field demonstration, however, will be needed before it can be said with complete certainty on what scale such operations are practicable and what the cost of the resulting product will be.

In addition to the direct benefits that might accrue from increasing the water supply available for beneficial consumptive use, the studies incident thereto may well lead to knowledge which will be useful in controlling or ameliorating air pollution—a serious problem in some areas. The increased run-off from the artificially produced rain or snow may, moreover, require changes in plans for future water-use projects and even in designs of dams and other works. If this additional water is to become available, its amount and location should be determined at the earliest possible date so as to avoid costly alterations of structures now being planned and designed by the Bureau of Reclamation and other Federal and private organizations. It is possible that some modification of existing structures may also be necessary.

The Weather Bureau of the Department of Commerce has for many years engaged in the measurement of atmospheric phenomena, the collection and analysis of precipitation records, and recently in the evaluation of techniques that have been suggested for producing precipitation artificially. The assistance of that agency and of all other organizations which have performed or are conducting research in this field will be sought.

I recommend the deletion of the word "transporting" in line 8, page 2, of the bills.

The committee may wish to consider adding to paragraph (g) of section 2 (p. 4, line 9) a proviso along the following lines:

"*Provided*, That prior to conducting any operations in the air the Civil Aeronautics Administration shall be consulted and no such operation which, in the judgment of the Administration, will constitute a hazard to the safety of air traffic within a described area and at a specified time if conducted at a proposed place and time shall be conducted at that place and time."

Your committee may also wish to add a new section between the present sections 2 and 3 reading as follows:

"The Secretary shall, with respect to the development of techniques for the production of water from the atmosphere, cooperate with the Secretary of Commerce to assure that the facilities and experience of the Department of Commerce are fully utilized. Research undertaken by the Secretary under the authority contained in this Act shall be coordinated or conducted jointly with the Department of Defense to the greatest practicable extent compatible with military and security limitations, to the end that research and developments under this Act which are primarily of a civil nature will contribute to the defense of the Nation and that research and developments in the same field which are primarily of a military nature and are conducted by the Department of Defense will be made available to advance the purposes of this Act and to strengthen the civil economy of the Nation."

We were advised by letter dated March 20, 1950, from the Acting Director of the Bureau of the Budget as follows:

"I am authorized to inform you that the President desires to have the Department of the Interior take the leadership in necessary research, experimentation, and demonstration designed to develop economic means of producing from sea water or other saline waters, water which is suitable for agricultural, industrial, municipal water supply, and other beneficial consumptive uses.

The President agrees that statutory authority for the necessary work should be sought and requests you to take the lead on behalf of the administration in recommending early enactment by the Congress of S. 1300 with certain amendments * * *."

All of the amendments thereafter suggested were recommended by us to the Public Lands Committee in connection with its consideration of H. R. 3123, Eighty-first Congress, to which reference has already been made, and are incorporated in the text of H. R. 6 and H. R. 7.

I note, moreover, that in his letter of March 16, 1951, to Senator O'Mahoney, the Director of the Bureau of the Budget, after recognizing that "the Departments of the Interior, Agriculture, and Commerce all have responsibilities and programs which may be deeply affected by further developments in weather control and modification," went on to say:

In the light of information obtained in recent weeks, we feel that it would be appropriate for the several Federal agencies concerned to continue whatever work they can under existing authorities and funds made available under those authorities. We are of the opinion that such further work as can be justified at this time can be carried on under the provisions of S. 5 as suggested for amendment by the Department of the Interior in its report. The authorities of that bill will permit full interdepartmental collaboration.

Finally, it would seem to this office that further information on attempts to alter weather conditions should be collected from whatever sources are available throughout the country and that such information should be presented to the Congress before legislative authorizations broader than those contemplated in S. 5 are enacted into law.

A copy of Mr. Lawton's letter is attached.

I am advised by the Bureau of the Budget that there is no objection to transmission of this report to the Congress and that enactment of the proposed legislation would be in accord with the program of the President.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., March 16, 1951.

Hon. JOSEPH C. O'MAHONEY,
Chairman, Senate Committee on Interior and Insular Affairs,
Room 224, Senate Office Building, Washington, D. C.

MY DEAR SENATOR O'MAHONEY: This is in reply to your request of January 11, 1951, for the views of the Bureau of the Budget on S. 5, a bill to provide for the extraction of potable water from sea water and other saline sources, and in further response to a letter of February 26, 1951, from Mills Astin, chief clerk of your committee, in which he asked that we consider S. 5 in relation to two other bills, S. 222 and S. 798, which would provide for the development and regulation of methods of weather modification and control, and of artificially inducing rainfall respectively.

In his 1951 budget message, the President said:

"Experience in recent years has shown that it may not be possible to meet the shortages of water, which are a threat in some areas, through our extensive water-resources program. I recommend, therefore, that the Congress enact legislation authorizing the initiation of research to find means of transforming salt water into fresh water in large volumes at economic costs."

As there are no technical obstacles in producing fresh water from the sea and other saline sources, such experimentation should continue, with particular attention to the whole matter of the economic feasibility of the project. Accordingly, it is the view of the Bureau of the Budget that authority should be provided to permit research into methods of extracting potable water from saline sources more economically than is possible under present processes.

On the other aspects of these bills, particularly those relating to the artificial induction of rainfall, and weather modification and control, the picture is by no means as clear. The principal difficulty, as we understand it, appears to be that the physical processes by which rain is formed and precipitated are not yet understood. Some of the foremost scientists in this field doubt whether there is sufficient experimental evidence to prove that precipitation can be successfully induced artificially. In our present state of imperfect knowledge the difficulties of controlling or modifying the weather would seem to be so great that any Federal program should be limited to research and the evaluation of existing knowledge and data. At this time, therefore, it would seem to us unwise, if not impossible, to attempt to settle the jurisdictional questions which the three bills raise. The Departments of the Interior, Agriculture, and Commerce all have responsibilities and programs which may be deeply affected by further developments in weather control and modification. For these reasons the Bureau has indicated that presentation to the committee of their views by all three Departments and any other interested agencies would be without objection from this office.

In the light of information obtained in recent weeks, we feel that it would be appropriate for the several Federal agencies concerned to continue whatever work they can under existing authorities and funds made available under those authorities. We are of the opinion that such further work as can be justified at this time can be carried on under the provisions of S. 5 as suggested for amendment by the Department of the Interior in its report. The authorities of that bill will permit full interdepartmental collaboration.

Finally, it would seem to this office that further information on attempts to alter weather conditions should be collected from whatever sources are available throughout the country and that such information should be presented to the

Congress before legislative authorizations broader than those contemplated in S. 5 are enacted into law.

Sincerely yours,

F. J. LAWTON, *Director.*

DEPARTMENT OF THE ARMY,
Washington 25, D. C., June 18, 1951.

Hon. CLAIR ENGLE,
Chairman, Subcommittee on Irrigation and Reclamation,
Committee on Interior and Insular Affairs,
House of Representatives.

DEAR MR. ENGLE: Reference is made to your recent request to the Secretary of Defense for an expression of the views of the Department with respect to H. R. 6, a bill to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes. The Secretary of Defense has assigned to the Department of the Army the responsibility of expressing the views of the Department of Defense on this subject.

As this Department has submitted to the Senate Committee on Interior and Insular Affairs a combined, coordinated report on S. 5, the companion bill to H. R. 6, on S. 222 and S. 798, related bills, a copy of this combined report is enclosed for your information. The views of the Department of Defense on H. R. 6 are fully expressed in the enclosed report on S. 5 and related bills.

Sincerely yours,

FRANK PACE, Jr.,
Secretary of the Army.

DEPARTMENT OF THE ARMY,
Washington, D. C., May 28, 1951.

Hon. EDWIN C. JOHNSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR SENATOR JOHNSON: Reference is made to your recent request to the Secretary of Defense for the views of the Department of Defense with respect to S. 222, a bill to provide for the development and regulation of methods of weather modification and control. Although your committee has not requested an expression of the views of the Department of Defense with respect to S. 5, a bill to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes, and S. 798, a bill to authorize the Secretary of Agriculture to conduct research and experiments with respect to methods of controlling and producing precipitation in moisture-deficient areas, for the convenience of the subcommittee which is considering those bills together with S. 222, and at the suggestion of the Secretary of Defense, the views of the Department on all three bills are incorporated in this report. The Secretary of Defense has delegated to this Department the responsibility for expressing the views of the Department of Defense on the mentioned bills.

The Department of the Army, on behalf of the Department of Defense, favors the enactment of S. 5, subject to the comments and recommendations set forth below, and is opposed to the enactment of S. 798 and S. 222 in their present form.

S. 222 sets out findings intended to establish the importance of the matter of weather modification and control; the proposed policy of the Congress, among other things, to regulate and supervise experiments and operations designed to modify and control weather; and the stated purpose of the bill, which is to effectuate the policies and establish certain major programs. The bill also provides for the establishment of a Control Commission much along the same lines as the Atomic Energy Commission, with advisory and liaison committees.

S. 5, with one exception, is substantially the same as S. 1300, Eighty-first Congress, and in general sets forth the policy of the Congress to provide for the development of economically feasible means of producing from sea water, other saline waters or from the atmosphere, water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the

Secretary of the Interior is authorized to conduct research and development work, to acquire patents, inventions, and other property, to cooperate with other governmental departments, agencies or instrumentalities, and to request other Federal departments, agencies and instrumentalities to provide assistance. Certain authority is also granted to the Secretary of the Interior to dispose of water and other products produced as a result of his operations under the bill. Authorization for appropriations of up to $25 million is contained in the bill, as well as certain provisions for indemnification, periodic reports to the Congress, and issuance of rules and regulations.

S. 798 directs the Secretary of Agriculture to conduct research and experiments and to take such further action as may be necessary to perfect methods of causing rain to fall in deficient areas. Other Federal departments are directed to make their records and data available to the Secretary of Agriculture. The bill also contains an authorization for appropriations.

The armed services have been engaged in basic studies of weather modification which have led to certain techniques now being tested. Experiments and tests to date have had some possible significance but their results cannot be considered conclusive as yet. The results to date indicate that under favorable conditions some local changes can be produced by artificial means. This is generally agreed upon by most independent experts. There is, however, considerable controversy as to whether cloud modification can effect major weather changes; for instance, there appears to be no hope at the present time to break a genuine drought by this means. The evidence that some changes can be induced is sufficiently strong, however, to make it desirable to explore further possible tactical and strategic implications. Current and prospective tests by the services also have possible military applications, the nature of which necessarily constitute classified information at this time.

There is a considerable element of doubt concerning the validity of results to the present because of cloud seeding activities of others, which may have had some effect on the tests conducted by the armed services. It is generally agreed that methodical, systematic and coordinated research should be encouraged. Large operations by irresponsible persons could seriously upset research activities of serious students in this field. Legislation which would protect the validity of experiments by providing for coordination of effort and, at the same time, not hamper vigorous prosecution of valid research is desirable. Such legislation should also provide means for protecting the public against the great danger of victimization, especially farmers and others who need water from time to time. The protective mechanism which is required should, however, be communsurate with the needs and at present it appears that this mechanism should be relatively simple and easily enforceable.

It thus appears that there is no basic difference of opinion between the armed services and the author of S. 222 as to the necessity of control of experiments in weather modification and control; the services feel, however, that the extent of valid scientific knowledge on the subject is not yet sufficient to justify a large and expensive control organization or the degree of regulation contemplated by the bill. It is believed that the mechanism to accomplish the necessary control could be established within the framework of presently existing Government agencies. Emphasis at this time should be on research with only so much control as may be necessary to ensure coordinated effort and to present indiscriminate and irresponsible attempts at cloud modification. This control could be provided for by a single bill which would vest in an existing agency, such as the quasi-judicial Interstate Commerce Commission, authority to issue regulations setting forth terms and conditions on which all seeding may be conducted, including a requirement that all persons, firms, or corporations engaged in the seeding of clouds shall furnish specified information and findings to the Weather Bureau.

Such a bill should also give to all Government agencies engaged in research in this field authority to indempify their contractors against liability for all damage directly resulting from their research. Appropriate language for such a section is contained in section 10 of S. 222, which provides generally for broad assumption by the Government of liability for damages resulting from the performance of contracts relating to weather modification or control. This section is broader than the provisions of section 5 of S. 323 (a bill to facilitate performance of research and development work by and on behalf of the military departments) in that it provides for sole responsibility by the Government for damages, and that no cause of action with respect to any such claim for damages may be maintained against the contractor but shall be solely by suit against the United States in the Court of Claims. The provisions of section 10 are not objectionable, even as

broad as they are, except the clause set forth on lines 2 and 3 on page 21, "whether due to the negligence of the contractor or otherwise." It is believed that the Government should not be an insurer of a contractor so as to protect him on account of his own negligent acts. The quoted clause should be stricken out from the section. In addition, there should be inserted in whatever section is equivalent to section 10 a provision authorizing settlement of claims by the head of the contracting agency and in such case, the second proviso of section 5 of S. 323 should also be included in the bill.

It is believed that a bill containing the foregoing provisions would be sufficient to meet present needs. Interested Government agencies would undoubtedly form a coordinating committee under the Interdepartmental Committee on Research and Development, or some other existing agency, who would advise the regulatory body, coordinate research activities of Government agencies, and review all the developments and recommend to the regulatory agency additional legislation as required.

The Federal Trade Commission under its authority to prevent "unfair or deceptive acts or practices in commerce" could be requested to exercise its authority with respect to false claims made by professional "rainmakers." This would prevent, to a great measure, the victimization of farmers and others who need water from time to time and who might be deceived by extravagant or false claims.

With respect to S. 5, which is described above, it is believed that express authorization to conduct research in cloud modification is not necessary for any Federal agency having an interest in the field. If the authority is not actually needed, it should be deleted from S. 5 because it might cast doubt on the authority of other agencies to engage in similar activities.

S. 798 is based upon the premise that rain can be made where and when wanted. To this extent the bill is misleading. Furthermore, this bill would accomplish very little in that adequate authority already exists in all agencies having interest in the field for the conduct of research in cloud modification. The provisions of section 2 (a) which requires all agencies to make all data relating to cloud modification available to the Department of Agriculture might be seriously detrimental to the national security because it might require the furnishing of such data even though classified for military security reasons.

The Department of the Army, in behalf of the Department of Defense, recommends that S. 5 be modified in accordance with the foregoing views and, as thus modified, recommends its enactment. The Department does not recommend enactment of S. 798 or S. 222.

The fiscal effect of S. 222 is unknown to the Department of Defense. The fiscal effect of S. 5 is apparent from section 8 thereof, which authorizes appropriations not to exceed $25 million. The fiscal effect of S. 798 is also unknown to the Department of Defense.

This report has been coordinated among the Departments and boards of the Department of Defense in accordance with the procedure prescribed by the Secretary of Defense.

The Bureau of the Budget advises that there is no objection to the submission of this report.

Sincerely yours,

FRANK PACE, JR.,
Secretary of the Army.

LETTER FROM ASSISTANT SECRETARY OF AGRICULTURE

MARCH *13, 1951.*

Hon. FREDERICK J. LAWTON,
Director, Bureau of the Budget.

DEAR MR. LAWTON This is in reply to your request for the comments of this Department on the bill, S. 5, to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, or from the atmosphere (including cloud formation), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

We believe the discovery of economically feasible means of producing fresh water from sea water might afford large benefits to agriculture in certain water-deficient areas, and would aslo produce far-reaching benefits to the public in other respects. Also of great concern to agriculture are those aspects of weather

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control that involve cloud dissipation, and other devices to reduce lightning, hail flood, and windstorm damage. At the request of chairman of the Senate Committee on Agriculture and Forestry we have also prepared comments on S. 798, which authorizes this Department to conduct research on methods of controlling and producing precipitation. We have favored enactment of that bill, subject to certain amendments. A copy of our comments on S. 798 is attached.

If, however, the committees considering weather control legislation prefer the enactment of this bill, S. 5, to further authorize the conduct of weather-control research in the executive departments, we suggest its amendment so as to authorize the Secretary of Agriculture to conduct research to ascertain the most practical use of the techniques of artificial induction of precipitation to provide moisture for crops and pastures, prevention of forest fires and other purposes, and to discover practical means of dissipating clouds so as to reduce damage from lightning, hail, windstorm, erosion, and floods.

We believe that the bill also might well contain provisions that in their conduct of research in weather control the Department of the Interior and Agriculture shall cooperate as closely as possible with the Department of Commerce, in view of experience and scientific staff available in the Weather Bureau of that Department. The possibility of utilizing the Department of Commerce as a coordinating agency for Federal research in weather control might well be considered.

With the changes suggested we would have no objection to enactment of the bill.

Sincerely,

K. T. HUTCHINSON,
Assistant Secretary.

MARCH 13, 1951.

Hon. ALLEN J. ELLENDER,
Chairman, Committee on Agriculture and Forestry,
United States Senate.

DEAR MR. ELLENDER: We have given careful consideration to the bill, S. 798, to authorize the Secretary of Agriculture to conduct research and experiments with respect to methods of controlling and producing precipitation in moisture-deficient areas, which you recently sent us for comments. This bill appears to assign primary responsibility to this Department for research into methods of inducing rainfall.

We are greatly interested, not only in the induction of rain or snow, but in the possibility of cloud dissipation or other devices to reduce windstorm, hail, and flood damage, and lightning activity, the latter being one of the important causes of forest fires.

We should like to have clear authorization to perform research in methods of weather control as it affects agriculture. In conducting such research we would plan to carry it on in close cooperation with the Department of Commerce. We suggest the desirability of the Department of Commerce having primary responsibility, or at least coordinating responsibility in view of the scientific organization already at work on this problem in that Department, for research in weather control among Federal agencies.

We should prefer that the authorization of such research be to the Secretary of Agriculture, rather than to specific bureaus of the Department. This provision would be in line with recommendations of the Hoover Commission that authorities be vested in the heads of agencies.

We, therefore, suggest amending section 1 of the bill, as follows:

"SECTION 1. That the Secretary of Agriculture is authorized, by contract or otherwise, to conduct research and experiments to discover practical means of dissipating clouds so as to reduce lightning activity, curtail formation of hailstones and serve other useful purposes, and to ascertain the most practical use of the techniques and principles of artificial induction of precipitation in providing moisture for crops and pastures, prevention of forest fires and other purposes: *Provided,* That the Secretary of Agriculture, in the conduct of such research and experiments shall cooperate as closely as possible with the Department of Commerce."

With these amendments we favor enactment of the bill.

If the committee should see fit to include authority to contract as provided in the above amendment, it may wish to consider providing means of protecting

contractors against claims which might arise in connection with carrying out contracts under this authorization.

The Bureau of the Budget advises that it has no objection to the submission of this report.

Sincerely,

C. J. McCormick,
Under Secretary

The Secretary of Commerce,
Washington 25, June 22, 1951.

Hon. Clair Engle,
Chairman, Subcommittee on Irrigation and Reclamation,
Interior and Insular Affairs, House of Representatives,
Washington, D. C.

Dear Mr. Chairman: This letter is in reply to your request for our views with respect to H. R. 6 and H. R. 7, bills providing authority for Government assistance to the development of processes for producing water suitable for agriculture, industrial, and other beneficial uses from saline waters and for research and regulation of weather modification activities.

There is attached a statement of our views concerning these bills.

The Bureau of the Budget advises us that there would be no objection to the submission of these views. If we can be of further assistance in this matter, please call on us.

Sincerely yours,

Thomas W. S. Davis,
Acting Secretary of Commerce.

Views of the Department of Commerce with Respect to H. R. 6 and H. R. 7 To Assist in the Development of Processes To Increase the Availability of Usable Water From Saline Waters and the Atmosphere, and for Other Purposes

H. R. 6 and H. R. 7 would authorize the Secretary of Interior to conduct research on the production from saline waters of water suitable for agriculture, industry, municipal, and other beneficial uses, and on the production of water from the atmosphere.

We believe generally that Government research and development in the field should proceed and we therefore favor the general objectives of these bills.

In drafting H. R. 6 and H. R. 7, the importance of the economic feasibility of processes developed for obtaining usable water from saline waters is stressed. We share this view and believe this to be the most important aspect of this development. For this reason we recommend that consideration be given to imposing a safeguard in the bill to provide that, to the fullest extent practicable, cost studies of any proposed method be made before a plant for the demonstration of that control is erected.

We also recommend that consideration be given to the fullest utilization of water resources presently available. Fresh water in vast quantities is discharged into the oceans from the rivers of the United States. Utilization of this river water, if possible, would, in large measure, eliminate the ocean-side costs of obtaining additional salt-free water, while transportation costs would, depending on the area, remain the same as for processed saline waters. Consideration should also be given to the increased use of sewage effluent for agriculture purposes, which would permit greater utilization of natural water resources for domestic and other uses. It is not clear that research on these two aspects of the problem would be authorized by H. R. 6 and H. R. 7, and the legislative history of this bill or the language therein should, in our opinion, be written to authorize their inclusion.

With respect to controlled production of water from the atmosphere, or rain making, although there has already been extensive research, much more is necessary before the practical value of rain making in general can be determined. Acting under authority of Public Law 691, Seventy-ninth Congress (49 U. S. C. 603, 60 Stat. 944), and Public Law 657, Eightieth Congress (62 Stat. 470) the Weather Bureau has conducted research in cloud and rain formation. This research and experimentation does not support the idea that relatively large amounts of rainfall can be produced artificially.

If we assume the development of artificial rain making, we must also assume that it will lead to climatic changes. Certainly the Weather Bureau, and the

Department of Commerce generally, would have a most direct and immediate interest and responsibility in these climatic changes. In the light of this interest and responsibility and in the light of the research already carried on by the Department in the field, which has resulted in considerable data, we believe that primary responsibility for this meteorological research should be continued in the Department of Commerce.

We recognize the potential danger of unrestricted experimentation in the control of weather, and of restrictions which are not uniform, and therefore recommend that, in addition to conducting such experimentation, the agency should be empowered to license activities in the field giving consideration to the exclusion by class from the requirement of licenses, such localized activities as fog dispersal at airports, frost prevention in orchards, etc. We would also favor the enactment of provisions safeguarding contractors hired by the Government to carry out experimentation in this field from liability arising out of their activities. We are taking up with the Bureau of the Budget a suggested modification for the purpose of providing close cooperation in research and meteorology. The proposal will be transmitted to the committee in a later letter.

Mr. ENGLE. The purpose of the bill is to provide for research in the field of converting sea water to fresh water on a large-scale basis with a view toward finding an economical means of production for the purposes of conserving and increasing the Nation's water resources. The bill would authorize not more than one demonstration plant for this purpose.

The bill also authorizes research in producing water from the atmosphere, including cloud formations, and provides that the water which might be produced shall become a part of the natural stream flow. It also authorizes the Secretary of the Interior to grant licenses under patent rights acquired under the act.

In addition, the bill authorizes the Secretary of the Interior to provide that in any contracts for carrying out these experiments the United States shall indemnify the contractor against liability on account of claims.

We have the authors of the bills here, Mr. McKinnon and Mr. Phillips. Would you gentlemen like to come forward for your introductory statements?

Pull up your chairs if you wish. We take witnesses by handsfull before this committee.

Mr. McKinnon, do you have a preliminary statement you wish to make?

Mr. MCKINNON. Yes, sir.

STATEMENT OF THE HONORABLE CLINTON D. M'KINNON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. MCKINNON. Mr. Chairman, first I want to thank you and your committee for giving attention to this bill. I understand Mr. Phillips has a pressing engagement that he has to get to very quickly and for that reason I would like to yield first to Mr. Phillips for his statement and then after he finishes I would like to say a few words too in regard to the bill.

Mr. ENGLE. I suspect Mr. Phillips is over there figuring how he can trim an appropriation, which is an important consideration right at this time.

Mr. MCKINNON. Maybe he wants to provide 25 million for this bill here.

Mr. ENGLE. I might say these are two of our most distinguished colleagues from California.

Mr. CRAWFORD. All over the country.

Mr. ENGLE. The California delegation is very proud of John Phillips, who served with me in the State senate, before me in the State senate of the California Legislature, and Clint McKinnon is an ex-publisher. He got demoted when he came to Congress, I contend, from San Diego. Between the two of them, they represent one of the greatest areas in the United States. We are very, very proud to have both of you gentlemen here. I will say for the record that you are two of the ablest and most respected legislators in the House of Representatives.

Mr. MORRIS. Mr. Chairman, that was a voluntary demotion, was it not?

Mr. ENGLE. Yes; that was perfectly voluntary on Mr. McKinnon's part.

I might say since then he has repented it a little.

With that send-off, Mr. Phillips, do you think you could make a brief statement?

STATEMENT OF HON. JOHN PHILLIPS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF CALIFORNIA

Mr. PHILLIPS. You make it very difficult, Mr. Chairman.

I thank you very much and I thank Mr. McKinnon because I do have another committee coming up right away and I would like to be there. I will make a very brief and informal statement.

I appear on behalf of H. R. 7, H. R. 6 being a companion bill and is my bill.

This bill is of very great interest to the district which Mr. McKinnon represents. This is the third session in which I have introduced a bill on this subject, and I am very much interested in this from the broad standpoint of the need of water and the possibility of using water which might otherwise be lost and also because of the specific needs of all the area in which Mr. McKinnon and I live. We have an increase in population which is unbelievable to people who have not been in our State in recent months or years, and the problems of water are now among the most serious problems we have.

The sources of water with us are limited. Of course, one of the sources would be rain, of which we have a very limited amount as compared to the East, and before your committee I understand you will take testimony regarding the production of further rainfall by seeding the clouds, and so forth, on which I do not testify today.

We then have the source of underground water or the rivers, which is the major source of water which we pump and control and put upon the land, and we have reached a reasonable saturation point on the possibility of using water from this source, although there are still rather extensive plans for using river water in various areas in California for the most beneficial use for all the people.

The third possibility is the purification of sewage water for the use of that water upon agricultural lands. We have never used it in the West because it is a rather unpleasant idea to most people, but it has been used in the South and specifically in the city of Corpus

Christi, Tex., where they used it for some years and then discarded it because of the expense.

There also is a possibility of the use of dual systems, as is used on the island of Guam, and that is the piping of salt water for specific uses, such as fire protection, flushing of toilets, or street cleaning, and matters of that kind. That is an expensive installation, and expensive because of the deterioration of the pipes.

Then, of course, there is the possibility upon which I testify today, and that is the distillation of sea water whenever the cost of it can be reduced to any economical figure.

So far it has been possible for us only to use it practically, as the armed services might use it in time of war, the Navy might use it on their ships, and rafts might have small equipment for that purpose, and where the cost was less important than the demand for the water.

Now, having been interested, Mr. Chairman, in that, as I say, for more than 6 years now, I have followed down each successive suggestion regarding the distillation of sea water and several years ago or about a year or a year and a half ago now, I guess, I became acquainted with the two brothers, Mr. Howard Davies and Mr. Elmer Davies, who had been very active in milk, in the drying of milk, and I had known of them during the war because of my interest in that agricultural development.

I am not going into details, but I do want to say that I discovered that they were applying somewhat the same principles on the suggestion of other people to the distillation of sea water. I followed it down. I became acquainted with them. I went over to Philadelphia myself and investigated the little pilot plant that they had set up in a work shop, in a machine shop, an electrical shop over there, and I am convinced as of this moment that that is the most nearly practical, the most economical method that has yet been discovered for the distillation of sea water.

Mr. POULSON. How much did that cost?

Mr. PHILLIPS. I would rather, if I may, Mr. Poulson—it will surprise you pleasantly—I would rather have Mr. Davies testify himself on that, and so my object in coming here this morning is to ask you if you will put on your list of witnesses the name of Mr. Elmer Davies as one of the partners, one of the inventors, of the Industrial Processes Co. of Philadelphia who have this device, and then to say to you that it is presently being considered very seriously, as he will testify, by several agencies of Government, as well as by private industries.

I had expected before this that the third largest installation would have been made.

Incidental to that and not of primary interest to your committee, but certainly of secondary interest to your committee, is the fact that in the process of building this or of developing this process of distillation, it was found that the same process also produces power for a very much lower consumption of fuel than was anticipated, and that is of very great interest to agencies of Governemnt including, I may say, to the Atomic Energy Commission.

The other incident to the process has been the separation of waste materials in certain industries which otherwise become a problem for their disposal, and only 2 days ago I discussed with one of the leading paper-box manufacturers in the United States the use of this to separate some of the material which are wastes from that process,

and produce a water-pollution problem and I found him more than a little interested, very much interested, and wanting to find out about it immediately.

I have no other testimony to give today, Mr. Chairman. My primary object is to ask you if you would put upon your list in my place of a lengthy testimony the man who can give you the specific details better than I can, Mr. Elmer S. Davies, and to say that I personally think that these bills are very urgently needed if we are to be in advance of the serious situation which the lack of water is creating, not only in broad areas, but in small areas where, for example, the distillation theory can be used.

Mr. MURDOCK. Mr. Chairman, may I ask, you say Elmer S. Davies?

Mr. PHILLIPS. Yes, sir.

Mr. MURDOCK. I find a Howard Davies mentioned.

Mr. PHILLIPS. That is correct. They are brothers.

Mr. POULSON. Mr. Chairman, while you are getting witnesses like that, I notice on our agenda we have men strictly from the various departments. I would like to suggest that you get someone like Mr. Thomas K. Sherwood, dean of engineering, MIT, who is thoroughly conversant with this problem as an expert.

Mr. ENGLE. We cannot have them all at once. The more orderly procedure seemed to indicate calling the Government witnesses first.

We cannot plow but part of this field today.

Mr. POULSON. I understand.

Mr. ENGLE. Of course, the No. 1 witnesses are always our distinguished colleagues.

Mr. POULSON. I would like to ask a question. You are talking about abandoning the idea of using sewage water; would that not be far more economical to distill for the use back on the land instead of converting this sea water?

Mr. PHILLIPS. If you are asking me a question, I do not think it is more economical, but I think where you are in—in certain areas where sea water is not more readily available, it would be the only thing you could use. You could not bring the sea water into there to distill it.

Mr. POULSON. You have no idea on the costs?

Mr. PHILLIPS. I will let Mr. Davies testify to that. He is full of figures.

Thank you, Mr. Chairman. I will retire.

Mr. ENGLE. Thank you, Mr. Phillips. We understand you do have to go to another meeting.

Mr. McKinnon.

Mr. MCKINNON. I would like to say, Mr. Chairman, if your reception is typical of how you treat all Congressmen your committee will be swamped with legislation. We will bring a lot of bills to your committee. We hope your hospitality indicates favorable action on this type of legislation. I recall last August, when we had this same type of legislation before your committee of how you and your committee members gave us a good reception then and your enthusiastic response to the possibilities involved in this bill.

We compare these hearings with those concerning earlier legislation before your committee in 1942 providing for the authorization of liquid fuel experiments which, as we all know, proved to be a great industrial asset to this country and more recently to our national defense program.

The chairman also pointed up the fact that we spent $2 billion on splitting the atom, eventually arriving at a great scientific discovery, the possibilities of which perhaps are endless. Still that may not prove to hold any greater benefits for humanity in the long run than the proposal which now lies before you on this sea-water bill.

We not only have your good will behind us, but it is a matter of record that this legislation has the sanction of the President and the various other Federal departments and agencies—the Department of State, Defense Department, Department of Agriculture, Department of Commerce, General Services Administration, Federal Power Commission, and the Federal Security Agency. All these departments have pledged their support and cooperation with the Secretary of the Interior, who is, under the provisions of the bill, authorized to conduct the research and development work involved.

From the beginning, I am glad to say, we have had the assurance and good will of a well-organized team—now we are asking for the authority to commence action.

Since my first days in Congress, I have acquainted myself with the many problems brought about by severe water shortages throughout the country. In discussions with the Secretary of the Interior, he advised me that he also recognized the great need for increasing the Nation's fresh-water supply and because of the acute shortages of water—especially in the Western States—he believed it imperative that each potential source of additional fresh water be explored exhaustively and developed to the maximum practical extent. The vast quantities of salt water right at our Atlantic and Pacific shores are potentially great national resources and I am confident that they can be tapped by American scientific methods to supply the rapidly expanding demands of our great metropolitan areas on both the east and west coasts. New York City's recent water shortage certainly lends great support to the crying need for additional fresh-water supplies. Just a few days more of dry weather could have had disastrous effects on this great city's population and industry.

I might add too that we have a lot of brackish water in the Middle West where water is in great demand and, if this experiment proved practical, could satisfy the great need in Oklahoma, Texas, and on up through those Western States where they are greatly disturbed by water shortages as we are in California and Arizona and many other areas in the West.

If the experiments in this requesed authority are successful, the increasing drain on the diminishing water supplies for irrigation of agricultural lands can be checked. More than 2 million acre-feet of water now required for municipal and industrial purposes in the California metropolitan areas can be released to meet irrigation requirements that are growing apace with California's increasing population and expanding national defense activities on the Pacific coast.

Water shortages are acute in many areas of the United States. Hundreds of thousands of acres of irrigated land are being kept in production only through serious overpumping of the existing ground water. Pumping for irrigation in some of the most highly productive areas in California, Arizona, and New Mexico during the past few years has been at rates more than double the safe yields as estimated by the United States Geological Survey. The same situation exists to a lesser degree in other western States.

Looking at our industrial fresh-water requirements—and so ably pointed out last year by the Secretary of Commerce in his testimony in behalf of this legislation—it is estimated that 23 gallons of water must be used to refine 1 gallon of gasoline, and since approximately 24 billion gallons of gasoline are produced each year, the petroleum industry must have accessible about 552 billion gallons of water each year. A more vivid example of our need for much greater supplies of fresh water may be shown by estimates reached by experts on the amount of water which will be required for the operation of a new plant now under construction at Brownsville, Tex., for the synthesis of gasoline and other products from natural gas. It is estimated that approximately 377 gallons of water will be required for each gallon of the finished product.

The water requirements of our other big industries throughout the country are equally as thought-provoking. Secretary Sawyer focused our attention on the obvious conclusion that no area of our country can hope to attract new industries unless it can count on a steady, easily procurable supply of fresh water. The purposes of my bill are a challenge to this evermounting problem.

The terrific population increase from 4½ to 7 million between 1940 and 1950 in the San Diego, Los Angeles, and San Francisco-Oakland metropolitan areas of California, with its resultant increase in industrial operations, literally soaked up all available fresh-water supplies; and estimates which forecast a 1960 population for these three areas of 8¼ million indicate the critical water shortage with which the west coast is threatened.

The present total annual use of water in California is 14,700,000 acre-feet of which 2,200,000 acre-feet are for domestic and industrial purposes. Requirements for the estimated 1975 population will total 25,600,000 acre-feet, of which 3,090,000 acre-feet will be for domestic and industrial uses. This would mean complete exhaustion of California's water resources and would constitute a ceiling on the State's growth of population, industry, and agriculture. It is obvious that we cannot afford to overlook the possibility this legislation affords us of obtaining additional, urgently needed fresh-water supplies.

I think it is agreeable to most everyone here today that what we say for California applies to every other State in this great country of ours.

Distillation by today's known methods is entirely infeasible for municipal and irrigation use both from the standpoint of cost and production quantities. Developmental research on a large scale is warranted in order to hasten the day when it may be possible to utilize sea water through distillation and, possibly, other artificial rain-making devices to supplement existing domestic, industrial, and irrigation water supplies. There is good reason to believe that the cost of producing fresh water from salt water may be off-set to a great degree by the commercial utilization of the resulting byproducts. I believe this fact will be brought out more in detail by those who will testify concerning the technical aspects of the distillation procedure.

As you know, this bill provides also for experimentation in cloud seeding, and in other artificial rain stimulation.

In conclusion, Mr. Chairman, I honestly believe that an investment by the Federal Government of $25,000,000 for the purpose of determining the practicability of producing fresh water by artificial means,

is a sound one, protected by the security of our collective scientific resources upon which we have so profitably and productively depended upon in the past. I am confident that our foresight will pay huge dividends in the future.

Mr. ENGLE. Thank you very much, Mr. McKinnon.

Mr. CRAWFORD. Mr. Chairman, I would like to ask a question.

Mr. McKinnon, if I understood Mr. Phillips correctly, these bills provide that whatever water is desalted, or whatever term you use for that, or whatever is captured from the skies, should be then treated as natural stream flows, is that correct?

Mr. MCKINNON. I do not think there is any such provision in the bill, Mr. Crawford. I think that will have to be determined pretty largely on the matter of water law in relation to water developed through the bill.

Mr. CRAWFORD. The chairman read that. Here it is.

> The bill also authorizes research in producing water from the atmosphere and provides that the water, which might be produced, shall become a part of the natural stream flow.

What is the main object of that provision?

Mr. MCKINNON. I think the main object from that provision would be not to upset your basis of your water calculations and your water priorities and your water rights in the various areas affected by your seeding program.

Mr. CRAWFORD. Some Member from California took the floor for a very brief moment and called the attention of the Members of the House to some court decision which has recently been rendered with respect to water rights. Was that you?

Mr. ENGLE. No.

Mr. POULSON. Mr. Yorty.

Mr. CRAWFORD. Mr. Yorty, and I gathered from what he said—I have not checked up on it carefully—that some decision has been rendered in California which throws this whole water question pretty much up in the air. Are you familiar with that?

Mr. MCKINNON. Yes, I am. I am very familiar with that. I think you are referring to a problem in my own district.

Mr. Engle knows exactly what Mr. Yorty is referring to and I do not, since I was not on the floor at the time. I imagine he must have been referring to the Santa Margarita suit now pending between the Federal Government and some private users up and down the stream.

Mr. CRAWFORD. If this bill is approved in its present form and touching on this point I have raised, would not such water as is recaptured from the sea, or from the air, through artificial promotion, come under that decision?

Mr. MCKINNON. No.

Mr. ENGLE. I say, the decision has not been made. I think, Mr. Crawford, that Mr. Yorty is referring to the fact that the Federal Government had filed a suit. Mr. Yorty contends that the allegations of the complaint are broad enough to assert title by the Federal Government in the natural flow of streams based on the sovereignty of the Federal Government rather than on their purchase documents as we have generally considered title by the Government and everyone else to water requires.

Now that has not been decided and the Government itself says it makes no such assertion, but this language, which is on page 4 of the

bill, which you referred to, would make the water which results from precipitation a part of the natural stream flow, and therefore subject to acquisition according to State law.

That is the purpose of it, to be sure that the Government, in precipitating the water, if it does precipitate any water, does not claim any title to the water after it hits the ground.

Mr. POULSON. It also states the Secretary of the Interior is going to issue a license on it. He is to grant license and patent rights.

Mr. MCKINNON. I think you have to differentiate between two things. One is a sea distillation proposition, primarily intended, I think, under present outlook at least, for municipal purposes. The other is a matter of seeding clouds and stimulating artificial rainfall under which this provision you mention would come.

In other words, the precipitation into the stream would constitute an additional stream flow which would be under State law, but as far as your desalting of water, which the Secretary of Interior is to grant licenses for the experimentation of, that does not have any connection at all with your stream flow or your artificial rain making.

Mr. SAYLOR. Mr. McKinnon just read your bill, page 4—

> *Provided*, That any run-off resulting from precipitation created artificially under the authority granted in this act shall be considered as a part of the natural stream flow and shall be available for use in the same manner as other natural accretions to the stream flow; and the Secretary shall have authority to grant, under such terms as he may consider appropriate, licenses under patent rights acquired under this act: * * *

and so forth.

Mr. MCKINNON. That particular language leaves out what I have just said.

Mr. CRAWFORD. The reason I raise this question now, Mr. Yorty referred to the Tidelands Oil case. Here we are, about to take action one way or another on a proposal which reaches out to the taxpayers of the country and calls upon them to put up a part of $25 million. The net result of that operation is to come under the provisions of State law. Of course, immediately you run right up against this old problem that forever is coming up, wherein if the Federal Government finances the proposition, or the appropriation, what authority shall the Federal Government have over that after it has attained success, and has started to operate it?

Now, whether it be Tidelands Oil, or whether it be water out there in the streams which the Federal Government is stepping in now and taking, the position it has sovereignty over, in preference to State laws, or whether it be a proposition of this kind, we run right straight into the basic problem; who is going to control it? Who finances and who is going to control?

You have your 160-acre law out there in the Central Valley where the Federal Government says one thing and the people seem to think something else. I just wondered.

Now, my second question is this: I happen to be one of those who thinks that we are facing a perfectly fantastic and terrific problem in the Southwest because of the populations there now and the millions of people who want to go there, and I do not blame them. Who would not want to go there and get away from these coal bills and gas bills and electric bills and cold weather and all the rest, if you

can settle down there and have a vacation and make a living? Who would not want to move there?

I put water at the top of the list as far as the Southwest is concerned and I think the question has to be answered and the water provided, if science can do it, and I believe that to such an extent my second question deals with line 14, page 6—

to be appropriated from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $25,000,000. * * *.

Suppose this could be done for $100,000? That is a small sum compared to the cost of a big irrigation project. That is a small sum, and if you are going to spend $25 million on it, and it appears successful, I do not want to get out on a limb and have somebody say, "You said the job could be done for $25 million." Who put $25 million in the bill? Whose idea was that?

Mr. McKINNON. The original bill last year called for a $50 million expenditure, and the Bureau of the Budget suggested it be cut down to 25, feeling that—and I think very wisely perhaps—feeling that if we had good results to show for the original $25 million expended, the Congress could then authorize and appropriate additional funds to continue the program.

Mr. CRAWFORD. Has anyone made a sufficient study of this—I am now talking about scientists involved—to make any rough estimate as to what these plants and experimentations would probably cost?

Mr. McKINNON. I received several letters from scientists across the country as a result of introducing the bill in which they expressed a satisfaction with the amount set forth.

Mr. CRAWFORD. That does not answer my question. They might express a satisfaction with $25 million to begin with, but if you come out here and tell me you want to build a plant, I say, "Wait a minute. What is the cost of it?" I do not want your estimate to get the foundation down and then come back later. I would like to have your estimate as to what the cost could be if it could be given. I do not know that it can be given.

Mr. McKINNON. I would not feel competent to give it, but I only expressed the fact they felt $25 million was adequate to carry on the start of a good program.

Mr. CRAWFORD. Twenty-five million dollars would start something, I should think.

Mr. McKINNON. They felt, Mr. Crawford, from that that they would have enough results to show whether the original $25 million expenditure could produce sufficient results to indicate whether we were sound in going forward with the program. I think it is far better to do it that way than to appropriate a hundred million we may eventually spend and end up with a dry hole.

Mr. ENGLE. Any further questions?

Mr. POULSON. Yes.

Now, Mr. McKinnon, it is your idea, in sponsoring such a bill, is it not, that you believe that this is not the solution to the water problem, but that you believe we should experiment and find something that can help us to alleviate our problems? You are not saying that this is the alternative? It is not a proven fact. It is still a question mark; is it not?

Mr. McKINNON. Well, first of all, I think we have to realize that this may prove satisfactory and it may prove a failure. We do not

know, but we are taking a chance in hopes it will produce what we are looking for. The second thing, this is no short-term solution to any of our water problems today. It is not going to take care of Arizona's problem, California's problem, New York's problem, tomorrow or the next day, but we know there is going to be a continuing water demand as our population increases and it is going to become more and more critical unless we do something basic to settle it. This is a basic solution if it proves practical, but it is not going to answer any of our immediate problems that are facing many of our communities and in many of our areas today.

Mr. POULSON. That is right. I agree with you on that.

You also are aware of the fact that there are methods today whereby fresh water is produced from salt water, but they are very costly and expensive and the purpose of this legislation is to have our experts further experiment in this field to develop processes by which they can try to cut down the cost. That is the purpose; is it not?

Mr. MCKINNON. That is true. There are several different methods now being employed by private people experimenting on their own funds, but all of these projects are very small and not efficient. There is not sufficient money in a private way to conduct experiments broad enough to determine whether we can bring the cost down to a practical and a reasonable cost for supplying municipal water.

Mr. POULSON. And the Government, of course, would be the one agency which should be doing this experimenting?

Mr. MCKINNON. I think the type of experiment indicates the Government should be the one for several reasons. In the first place, the people who benefit will not necessarily be the ones who invent the machine, but the people who benefit from the water, the broad social aspect and community aspect of it.

Mr. POULSON. Will this legislation also allow this: In other words, if some individual should find a method, I understand the Secretary of the Interior would be given permission to grant him patent. In other words, we have to have an incentive.

Mr. MCKINNON. That is right. There is nothing in the bill that prevents that. In fact, the Secretary is given the power to do that.

Mr. MURDOCK. Mr. Chairman.

Mr. ENGLE. Mr. Murdock.

Mr. MURDOCK. Once before I was reminded that it was the Congressman from San Diego who took the great interest in this proposed legislation, and I think there must be a very good reason for that.

This bill has wide meaning, but it has a specific meaning to your city; does it not?

Mr. MCKINNON. We have a lot of water right out in our front door that is not much use to us in a drinking way or an irrigational method and we have water shortages all through our district that this could help solve if we ever got a system figured out.

Mr. MURDOCK. I read recently—not very recently, but I read recently—a letter from an engineer in San Diego directed to a former chairman of this committee and in it he pointed out the need of just such a measure as you are proposing and one of the things he mentions specifically is that it was not safe for a great city like San Diego, or Los Angeles, to be too dependent upon long aqueducts which might easily be put out of commission by human or natural causes. That was the purport of his letter.

I do not know that that letter was ever read to this committee, but I think possibly it ought to be made a part of this record because of that point.

Mr. McKINNON. Of course, I do not know any water installation, Mr. Murdock, whether it would be locally or over long range of country, that could not be destroyed by a bomb rightly placed or a saboteur, so I think all of our water is in jeopardy, but it is possible to augment all sources of water from a broader source.

Mr. MURDOCK. That is true, and if possible have more than one target that might be destroyed by an enemy, for instance.

Mr. ENGLE. An earthquake could come along, too.

Mr. MURDOCK. An earthquake could, of course, do the same damage, but if we were dependent upon one single lifeline, an aqueduct, that would be a greater hazard, of course, so that as a military protection—as a military protection—it would be well if Uncle Sam, for instance, for his great port, had a few barrels or buckets available in case the general supply might be damaged.

This was the question, Mr. McKinnon: I did not quite get all of your figures, but I get the general impression that industrial development calls for many, many times more water per capita than ordinary human consumption. Is that not true?

Mr. McKINNON. That is true.

Mr. MURDOCK. Is it not true that in all of our city buildings we have depended upon ordinary biological uses for human consumption and for use of human beings in our cities and at such a rate we may find that this city requires 125 gallons per capita annually. This city may be 150 gallons per capita, and now we find that some cities use a thousand gallons, or 2,000 gallons per capita. Surely the citizens of the last city do not take baths twelve times a day. That is not the reason for that enormous increase; is it?

Mr. McKINNON. Well, I would guess that the city that uses an abnormal amount per capita would be cities that are in dry communities, where they have to irrigate their lawns and irrigate their flowers, and have no rainfall at all, where in some places like Washington we get enough rainfall where we do not have to water our lawns or water our gardens.

Mr. MURDOCK. I think I am going to have to disagree with you. I do not believe you guessed the correct answer. The correct answer in my judgment is not even swimming pools, or watering lawns. The correct answer to that enormous increase in use is industrial uses.

You said a moment ago that it took 23 gallons of water to refine a gallon of gasoline, and if you take all the industrial processes, you will find that they mount freely. That makes the per capita water cost of an industrial city ten, twenty, a hundred times greater than the per capita water cost of a residential city.

I think that is probably the correct answer. Maybe the experts can bring that out a little later, but the point I wanted to make is this:

If our coast cities—your coast city and others—are going to become expanding industrial cities, they have got to have tremendously more water in volumes than they would need as mere residential cities and I think we are going to find that that volume is so great that we cannot depend upon surface stream supply.

If we look ahead industrially, I think we are going to see your bill has a tremendous importance.

I did not intend to say quite that much.

Mr. McKINNON. Those were very good comments, Mr. Murdock. Thank you.

Mr. ENGLE. Are there any further questions?

Mr. SAYLOR. Yes; Mr. Chairman. I have several questions I would like to ask Mr. McKinnon.

Mr. McKinnon, I notice in both of these bills that you have placed not only the reduction of potable water from salt water, but also combined producing of water from the atmosphere. Why have you combined those two things in one bill?

Mr. McKINNON. Because there is a considerable interrelationship between any experimentation that can produce more water for a given area. In certain inland areas cloud seeding is a practical development, or at least it holds promise of development for water in that particular inland area. They have no sea water to draw upon. Sometimes they do not even have brackish water in the river to draw upon.

On the other hand, in the coastal areas where the sea water is readily available, that type of experiment lends easier to development of water than the cloud-seeding procedure would offer.

Mr. SAYLOR. The reason I asked that question, it seems to me that the first one of your methods, basic methods of producing potable water from sea water, involves no potential liability as far as the Government is concerned, and the second one involves a great deal of potential losses on behalf of Uncle Sam.

By experimenting with the production of potable water from sea water, pumping it then to where it is needed, you do not have any danger of lawsuits on account of floods. That is a matter that you can control, but, as near as I know, if you seed clouds by any of the known methods, and there is a precipitation which is normal or in excess of any amount, and somebody is damaged, it seems to me that you have set out to produce a result and you have produced a result and somebody has been damaged and there is a lawsuit in somebody's hands, and it seems to me that you are treading very closely to a lot of public liability in the second, whereas you are not in the first.

Mr. McKINNON. I can quite understand your concern on that. May I point out, however, Mr. Saylor, that these rainmaking experiments are now going on in many places in the country. They are going on without any sanction or any control whatever and I think it may be well to get these things under the umbrella of some regulation and some responsible authority to coordinate these efforts, rather than just let them go along as they are going now in more or less bootleg fashion.

Mr. SAYLOR. I have no objection to thoughts along that line. My only thought was as to the advisability of putting them both in the same boat.

That is the first thing.

Mr. ASPINALL. Will the gentleman from Pennsylvania yield for an observation at this place?

Mr. SAYLOR. Yes, sir.

Mr. ASPINALL. I do not understand—you used the word "bootleg" to insinuate it would be an illegal prosecution?

Mr. McKINNON. No; I meant it was unregulated.

Mr. ASPINALL. Unregulated perhaps would be better.

As I look at the map on the stand, I notice that the State of New Mexico and the State of Colorado are almost universally agreed upon a program of seeding clouds, or bringing moisture out of the air other than by rainfall. I did not want my State to go down as one which was universally engaged in bootlegging.

Mr. SAYLOR. The second thing I have noticed with regard to this bill, Mr. McKinnon, is that on page 3 you authorize the Secretary of Interior to purchase secret processes, technical data, inventions, and patent applications.

Why was that put in the bill?

Mr. MCKINNON. Well, I have had several people come to me with ideas and technical processes they call secret. They claim they are their own inventions. They hold a lot of claim on what it can do in way of development of this program. If those things, after discussion with the Secretary of the Interior, look attractive and look like they can be productive, I think if we can buy into a method it can save us an awful lot of experimentation funds.

Mr. SAYLOR. I am very frank to tell you that for myself—I do not commit any of the rest of them—I am not in favor of having the Secretary authorized to purchase secret processes because there is no limit to the potential that could turn up. Every crackpot in the country could come down and get a friend in the Interior Department, and we would pay out a lot of money.

Mr. MCKINNON. I will grant you there will be a lot of fellows show up with secret processes trying to peddle them, but I do have enough confidence in the integrity and business judgment of the Secretary of the Interior to have confidence he is going to be able to separate the wheat from the chaff.

Mr. SAYLOR. That, sir, is a matter of opinion. Everybody does not share that opinion.

That is all.

Mr. ENGLE. If there are no further questions, Mr. McKinnon, we thank you very much for your presentation before this committee.

Mr. MCKINNON. Thank you, Mr. Chairman and members of the committee.

Mr. ENGLE. Now we have a list of the Interior witnesses before us. Mr. G. W. Lineweaver, Assistant Commissioner of Reclamation, I believe will introduce their testimony.

Mr. LINEWEAVER. Mr. Chairman, I will yield to the departmental witnesses after I submit for the record, as chairman of the Interdepartmental Committee named by the Secretary of the Interior last year, reports from the Department of Commerce, the Department of Defense, Department of Agriculture, and the Department of State, the Public Health Service and General Services Administration, on S. 1300 and the House bills, which were the predecessors of H. R. 6 and 7, and S. 5. Then Assistant Secretary Warne will present the salt-water phases of H. R. 6 and 7. Under Secretary Searles will discuss the artificial precipitation phases, and Commissioner Straus will then present across-the-board material.

(The information is as follows:)

STATEMENT OF THE DEPARTMENT OF AGRICULTURE

The Department of Agriculture endorses this bill because we believe it offers possibilities of affording important benefits to the people of this country. While

we cannot predict all the potential benefits, it is apparent that a cheap process for converting salt water to fresh in large quantities might free our large seaboard population centers from dependence on limited water supplies transported overland. It is conceivable that with cheap, dependable, and unlimited water supply from the sea, some of these cities could release considerable quantities of water now moved overland, for use in irrigating productive soils now lacking a water supply. Furthermore, some of this released water might be delivered to areas close to large population centers, through existing conduits, to use in producing crops for these urban markets, thereby saving transportation costs.

A cheap process might also offer prospect of irrigating land at feasible transportation distance from tidewater at less cost than would be required for the development of areas necessitating expensive storage and long overland movement of water. To have such a process available would fully justify efforts to develop it for future use.

It is also possible that experiments to develop a cheap process of salt-water conversion might disclose possible ways of desalinizing some of our stream and ground-water supplies so as to overcome the difficulties in using them for irrigation.

While these direct benefits to agriculture may be overshadowed by those to domestic and industrial users of water, and to the Nation through having stand-by sources of supply in case of war, the combined potentialities of the undertaking justify the effort.

EXCERPT FROM LETTER FROM THE DEPARTMENT OF STATE TO THE SECRETARY OF THE INTERIOR DATED MAY 8, 1950

The Secretary of the Interior has pointed out the extreme importance of this program as it related to our natural resources and national defense. In addition, the Department feels that as soon as economically feasible processes are developed they will be valuable in connection with our relationships with friendly nations. They will be valuable contributions to the administration of policies which depend on ample crop production, which promote the interchange of scientific and technical information, and which arise under treaty obligations in respect to border water allocations and pollution. This know-how will aid in the Department's present technical cooperation efforts, and also in the expansion of such efforts if pending legislation concerning technical cooperation is enacted, particularly as many of the underdeveloped areas of the world are arid or face water-shortage problems.

Sincerely yours,

JOHN E. O'GARA,
Deputy Assistant Secretary for Economic Affairs
(For the Acting Secretary of State).

STATEMENT BY DR. HELMUT E. LANDSBERG, PREPARED FOR PRESENTATION BEFORE THE COMMITTEE ON INTERIOR AND INSULAR AFFAIRS, UNITED STATES SENATE, ON S. 1300, A BILL TO CONSERVE AND INCREASE THE NATION'S WATER RESOURCES

My name is Helmut E. Landsberg. I am executive director of the Committee on Geophysics and Geography of the Research and Development Board, Department of Defense.

The Department of Defense favors the enactment of Senate bill 1300, Eighty-first Congress. The bill deals with research and development designed to lead to an increase of the water supply of the Nation. Water for beneficial consumptive use is one of the most strategic materials.

An adequate supply of water of satisfactory quality is essential not only for the peacetime economy of the country but also for waging a modern war successfully. Without sufficient water supplies cities and concentrations of population cannot exist; industry cannot produce the needed materials and equipment, and agriculture cannot meet the requirements for food production.

The installations, facilities, and manufacturing establishments operated by the Department of Defense consume water in large quantities.

The means of modern warfare also endanger water-supply systems. Reservoirs and dams are exposed to overt or covert enemy action. Surprise attacks can be expected in any future war. They may include attempts to contaminate the water supplies of the country.

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At present the water supplies of the Department of Defense installations are mainly drawn from ground-water and surface sources. In a few cases where such supplies are inadequate, artificial means of producing the necessary water have to be resorted to. The installations of the Department of Defense use, wherever possible, water systems owned by private business or municipalities. Approximately one-half of the present consumption of these installations is purchased from such sources. In some cases, of course, Government-owned facilities have to be developed and operated.

In the event of a national emergency, large amounts of additional water supplies will be needed. A consideration of the water uses of various nations shows a close relation between industrial and agricultural productivity and the use of water. The United States, which in this respect leads the world, uses by far the most water. The more backward a country, the less water it uses, and in the least-developed areas water is only used for drinking, cooking, and primitive sanitation.

A few decades ago a supply of 100 gallons of water per capita per day was considered ample. Now more than 200 gallons per capita per day, for municipal and purchased industrial and commercial use, are not out of the ordinary.

During the last two wars, although the water resources of the United States were greatly strained at times, the Nation was fortunate in having adequate rainfall replenish its supplies. Had the shortages of rainfall that characterized the decade of the thirties coincided with the peak water demand of the war facilities, the war effort would have been seriously handicapped.

Until rather recently, water supply was generally taken for granted and, as recently as the opening stages of World War II, construction of military camps or industrial facilities were commonly well advanced before consideration was given to the potential sources of water. More than 300 potential sites for war facilities had to be abandoned or plans had to be severely modified because water supply was found to be insufficient or unsuitable.

The most serious aspect of the water supply problem is the increased requirement for industrial use that has to be anticipated for an emergency period. These requirements run into the billions and even trillions of gallons per year for some of the most critical war production industries. To enumerate but a few, these include steel, oil refining, paper pulp, synthetic rubber, aluminum, airplane engines, industrial alcohol, cotton-mill textiles. At the peak of production during World War II, the steel industry required, for example, 1,800,000,000,000 gallons of water per year; oil refining at the same time used 1,400,000,000,000 gallons of water per year. The other industries required somewhat less but still the figures are astronomical.

In a future war the requirements are likely to be stepped up even beyond the enormous values quoted. At the present time, that is in 1950, we consumed in this country for all industrial operations, steam generation for electric power, and railroads as much as we consumed during the peak of World War II, namely, around 29 trillion gallons per year. It is estimated that at the peak of a possible war that might occur in the next few years, the annual requirements for these uses will rise to 42 trillion gallons. That is an increase of about 20 percent beyond the total present uses of water for all purposes, including agricultural, industrial, steam power, domestic consumption.

The possibility to have to supply this water during a period of drought years looms as a sinister specter that might weaken the Nation's strategic potential seriously. Any effort to create by appropriate research and engineering development additional water supplies is, therefore, in the interest of national security.

The agencies of the Department of Defense have been confronted with the problem of water shortages in many phases of operation. They range from keeping individual sailors, soldiers, and airmen alive on drifting rafts and lifeboats, to the supply of fresh water on ships and submarines, to furnishing water to large bodies of troops in dry regions and for isolated strategic stands and bases for which local water supplies were inadequate. The solution of these problems required considerable research and development work. While the work on these specialized aspects continues, it can be stated that solutions have been found. The majority center around the production of pure water from salt or sea water. Many scientifically possible avenues were explored, including certain chemical methods. These proved to be far too costly to produce fresh water from sea water. The only practical method for large-scale sea-water conversion has been the distillation method.

The solutions now at hand are not on a competitive, economical scale, but when water is needed to sustain life of our fighting men, to increase the cruising range of our ships, or to occupy strategic positions, the factor of cost is not the most

important one. However, the know-how acquired in this research and development work would form an excellent basis from which to start the work envisaged by S. 1300. All the information on this subject now on hand in agencies of the Department of Defense would, of course, be made available to the Department of the Interior should they embark on this work under the authority to be given by this legislation.

Let me summarize briefly for you what has been accomplished. The Department of the Navy, for example, has for over 40 years been manufacturing its own sterile, potable, fresh water aboard Navy vessels by the distillation of sea water. This water is used for drinking purposes, for boiler feed, and storage battery make-up, as well as for laundry and cooking. Distillation aboard naval vessels is accomplished either by low-pressure steam or vapor-compression distilling plants developed by the Navy in 1937. They have capacities up to 2,000 gallons per day. These require cleaning at intervals from 250 to 500 hours of operation because of rapidly forming scale deposits. Large vessels, driven by steam turbines, have been equipped with low-pressure steam distilling plants with capacities ranging from 4,000 to 40,000 gallons per day.

These operate on surplus of auxiliary exhaust steam. The heat of this steam would otherwise be wasted and the distilling units are superior from the points of view of weight, space, efficiency, and maintenance.

The Department of the Navy is now proceeding with the development of a high-capacity distilling plant under contract with the Bethlehem Steel Corp. This design will eliminate some of the cleaning problems and the large vapor pipelines required by previous designs. Other research work in progress aims at reducing the scale formation on the tube surfaces of the installations needed for Diesel-driven vessels in order to enable the distilling units to operate for sustained periods at maximum capacities. Much of this research is, of course, peculiar to the proplems encountered in shipboard use.

The Department of the Army, through the Corps of Engineers, under the exigencies of World War II also had to carry on development work on producing potable water from sea water. The global aspects of the conflict led to fighting and logistical operations in areas of the world where fresh water was not existent in sufficient quantities. The major requirements were for distilling units that were readily portable. In this development work, too, the conclusion was that the distillation process offered the only approach that would satisfy the military requirements. Originally equipment with a capacity of 1,000 gallons of water per day was developed, consisting of one evaporator and one condenser. Later double- and triple-effect units were developed. In the multiple-effect equipment the latent heat of steam from the first evaporator is used to boil additional sea water in a second evaporator and this is repeated for additional evaporators in the system. The addition of second and third evaporators increased the efficiency of the distillation process. To keep the equipment portable this was the limit of practicability for Army use.

Stationary equipment of larger type for land installations have also been built, based on the vapor compression principle. On June 1, 1950, such a plant will start service testing by the Corps of Engineers at Kindley Air Force Base near Hamilton, Bermuda. This will have a capacity of about 30,000 gallons per day. The estimated cost at current fuel prices will be about $1.50 per 1,000 gallons of water. Further units planned for development by the Army include portable types of up to 7,200 gallons per day and up to 100,000 gallons per day for stationary units.

The original equipment was quite inefficient. It used 1 pound of fuel for every 12 pounds of water produced. At the present time an efficiency of 200 to 1 can be readily anticipated, i. e., for each pound of fuel burned 200 pounds of water will be produced. This roughly seventeenfold increase of efficiency is the result of just a few years of research and development work. The research work contemplated under the pending legislation S. 1300, which would not be hampered by limitations inherent in the military and naval use, might very well lead to even more economical solutions. The vapor-compression system has not yet been driven to its ultimate possibilities. For example, it might be combined in some areas with high vacuum distilling units and that may reduce costs very considerably.

For large land-based installations it would, from current experience, seem quite feasible to incorporate large distilling units with existing facilities at steam power plants. It is estimated that the latent heat now wastefully discharged from such plants could be used to produce about 5 pounds of water per pound of turbine

exhaust steam. Such combination plants would bring fresh water production from sea water much closer to an economically attractive range.

In brief, the research experience in the Department of Defense leads to the conclusion that production of potable water is technically feasible and future work may well make it economically attractive. This work should be undertaken in peacetime. It would not only be of large potential benefit for the conservation of limited natural water resources in the civilian economy but also might become an invaluable asset in a time of war.

With respect to the production of water from the atmosphere, especially from clouds, no such positive statements can be made at this time. In this field we are still in the phase of basic studies on the physics of clouds. We are still trying to wrest some of the secrets from nature. The processes of rain formation—and one step removed rain making—are beset with a great many unanswered questions. Many of these answers are still in the controversial stage. There is no conclusive evidence as yet that we can pin any hopes on producing at will economically important amounts of water by presently known techniques. One of the major difficulties is that even under the best circumstances, rain might possible be induced if nature provides the moisture and forms the clouds. In cases of drought conditions, when the water problem is really critical, the skies may remain cloudless for days on end. Basic research into the physics of clouds is very important for several reasons beyond that of making rain. As a byproduct of this research, new knowledge may be gained to throw some light on the open questions, nevertheless, there is some hope on the basis of present knowledge that, under favorable circumstances, precipitation may be induced from clouds in as yet unknown quantities.

Statement by the Secretary of Commerce

There is a very widespread opinion that industrial consumption of water is minor in relation to public use. This opinion is substantially incorrect, and is probably one of the reasons for the insufficient awareness in the public mind of some of the factors which are presently believed to cause the Nation's insufficient water supply.

A glance at just one industry—the petroleum industry, will show how fallacious this opinion is. For example, the Baton Rouge refinery in Louisiana, although it consists of only one plant, uses more water than the city of Cleveland. The Bay Way refinery in New York in turn uses more water than the city of Buffalo. The pumps at Baton Rouge send water through their cooling towers at an average rate of approximately 260 million gallons per day. In spite of the fact that the refinery makes every possible effort to restore the water it uses to its original source, it must add about 13 million gallons per day to its system to make up for the loss caused by evaporation, leakage, and spray.

As a matter of fact wherever water is used for cooling in industry there is always a certain amount of loss. Petroleum experts estimate that 23 gallons of water must be used to refine 1 gallon of gasoline. Since approximately 24 billion gallons of gasoline are produced each year the petroleum industry must have available to it about 552 billion gallons of water each year. Some 3 percent of this amount is unrecoverable with the result that about 17 billion gallons of water are lost each year in the production of gasoline alone.

These figures are not in any sense to be taken as a condemnation of the petroleum industry; as a matter of fact that industry is known to operate on a very sound technological basis. Rather they are offered to indicate that an industry, in order to operate in a given locality, must not only be assured of a large initial water supply but must also be certain that there is enough water to replace what is lost each year.

As a matter of fact, particular attention should be focused on newer industries and plants since they are not as likely to be restricted by existing plant design and know-how as are the older ones. While, for example, 23 gallons of water per gallon of gasoline may seem relatively high, the plant now under construction at Brownsville, Tex., for the synthesis of gasoline and other products from natural gas will very likely require some 377 gallons of water per gallon of finished product. In the rubber industry it is estimated that 160 gallons of water are needed in the production of 1 pound of butadiene, and in the case of the rayon industry 100 gallons of water are required in order to produce 1 pound of viscose rayon.

Other large industrial users of water include the steel industry, about 36 gallons to 1 pound of steel; the smokeless-powder industry, about 25 gallons to 1 pound of

smokeless powder; the paper industry, about 26 gallons per pound of paper; the sugar industry, 10 to 14 gallons for each pound of refined sugar; and the textile industry which required about 47 gallons for each pound of finished textile product.

It should be noted that where water is used primarily as a cooling agent, as is the case in the petroleum industry, not only may impure or salt water be used to a large extent, but the amount of water lost is relatively small. Thus the Bay Way refinery in New York satisfies 97 percent of its requirements by the use of sea water. However, the remaining 3 percent, or about 7.8 million gallons a day, is required to be fresh water. As has already been pointed out, of the amount of water used each day, only about 3 percent is unrecoverable.

However, where water is used as an inherent part of the process of manufacture in the vast majority of cases only fresh water can be used, and the amount lost is considerably in excess of the 3-percent figure cited in the case of the petroleum industry unless special processes are used to repurify the water. The paper industry, for example, must replace or purify each day almost all the water it uses because in the course of the manufacturing process the water becomes impure. The same comment is equally applicable to the textile and dye industries, to the leather industry, and to all other industries which employ fresh water in a manner which requires the addition thereto of chemicals and other matter.

It is important to remember that in the normal manufacturing process not only is a large amount of water made unrecoverable but also that the return of the used impure water to its source may have the effect of rendering unusable a large additional amount of water. We have all long been aware of the problems created by the establishment of a manufacturing plant on a river or stream with the result that the water becomes polluted and unusable by those situated downstream from the plant.

The conclusion is obvious: No area of the country can hope to attract new industries unless it can point to a steady easily procurable supply of fresh water. No new plant is constructed or an older plant enlarged without a detailed preliminary investigation by designers and engineers to determine the accessibility of a satisfactory water supply. As a consequence, many areas can have no hope of increased activity until they can furnish industry with the needed water. Other areas which formerly had an adequate water supply are now becoming alarmed over dropping water tables as the supply of ground water decreases. An increasing source of trouble, moreover, is the fact that, in the areas adjacent to salt water, falling water tables tend to bring about infiltration of salt water, thus partially salinating the water already there.

There can be no question that the enactment of this bill might afford a solution to the problems created by an inadequate water supply. Enough advances have been made in the field of converting salt water to water which is usable for many purposes to indicate that further research may well reveal an economical method for utilizing the vast water resources which surround this country. We, therefore, urge the enactment of this bill so that the vital research needed may go forward at once.

STATEMENT BY WILLIAM E. HOLY, DIVISION OF SANITATION, PUBLIC HEALTH HEALTH SERVICE, FEDERAL SECURITY AGENCY

1. Severe droughts in the past have introduced serious public health hazards in certain areas of this country owing to deficienices in public water supply. The availability of an abundant supply of safe water would have averted the illnesses and inconveniences that resulted from the droughts.

2. The availability of equipment that could produce an abundant supply of potable water from saline water would be a safeguard of tremendous importance during an acute emergency such as might occur during a war.

3. Experience of the Public Health Service in the observation of distillation equipment on board vessels shows that such equipment may be relied on to furnish safe water under most operating conditions. Limited experiments carried on by the Public Health Service at Quincy, Mass., further demonstrated this reliability in a satisfactory way.

STATEMENT BY P. F. SEWARD, COMMISSIONER, COMMUNITY FACILITIES SERVICE, GENERAL SERVICES ADMINISTRATION (SUBSEQUENTLY HOUSING AND HOME FINANCE AGENCY)

This agency has been in close contact with the water needs of communities for the past 16 years. In the period of 1940–46, operating as Defense Public Works and War Public Works for the express purpose of correcting deficiencies in essential facilities which would hamper the war effort, the organization was required to provide water for both civilian and industrial use by any means. The rapid expansion of industry and contingent communities exposed the deficiencies in water supply in a most abrupt manner.

The normal expansion and improvement programs of nearly all of the larger communities contemplated a gradual increase in water demands; however, the acceleration of production due to defense and war demands brought water problems, that would normally require 20 years for accomplishment, into immediate view. This increased demand was not due entirely to accelerated production and the resulting concentration of people; new processes, new types of machine required enormous amounts of operating, washing, and cooling water. The demands for process water rapidly depreciated the potable water supply or caused radical changes in distribution patterns. Where the supply of clean water was limited by source restrictions or treatment plant capacities it was found expedient and effective to provide untreated water for industrial use if not unsuitable for the manufacturing processes. This might be classed as a conservancy measure.

The demand thus developed by the combination of circumstances above described has not decreased greatly. Many of the production processes developed during the war period are in common use today in all kinds of manufacturing plants. Many communities that depend entirely upon specialized activities such as mining, agriculture, oil production, etc., have found that to balance the economy of the area, industry of an appropriate kind is needed. The sufficiency of the water supply is one of the first questions asked by prospective investors and it is frequently found to be deficient for a desired purpose.

In the arid and semiarid lands the need for fresh water in quantity is uppermost. Since the beginning of history men have sought a practical means of converting salt or chemically charged water into a potable or fresh water at a cost that they could afford to pay. We have conducted experiments in sollar distillation of salt water in the Tropics for the purpose of ascertaining the feasibility of that process under field conditions. The record indicates that potable water may be obtained by this method under certain climatic conditions, particularly in arid or semiarid areas where no other dependable source exists. This small-scale experiment was discontinued after a period of about 3 months due to lack of funds to continue the work. This method of water production should be given all of the effort necessary to either accomplish the desired result or to prove the impossibility of practical accomplishment.

The basic factor in the potable-water problem is the source of such water. The transportation and distribution is a problem of mathematics that can be solved by comparative studies and estimates. Treatment processes are such that the reuse of water by disinfection and clarification can be given thoughtful consideration. This again may be classed as conservation rather than development; however, the purpose of new sources of potable water is to maintain a balance between supply and demand of the most important element in life on earth. Studies in conservation must go hand in hand with basic source development.

Mr. LINEWEAVER. Mr. Bennett, Assistant Director of Project Planning is the technical witness who will be available to answer questions.

Mr. ENGLE. What is this interdepartmental committee you refer to?

Mr. LINEWEAVER. The President named the Secretary of the Interior as the coordinator of all activities with respect to legislation in behalf of the salt-water research, and the Secretary named me as his general representative and as chairman of the interdepartmental committee in order to bring together the views of all of the departments concerned with water resources and salt water. Each of the departments and agencies named a representative on this committee. That committee submitted statements last August when we had the hearings on the predecessor of this bill and before this committee

I will refer to that record. Those who were named as members of the committee are as follows:

Department of the Interior: Goodrich W. Lineweaver
Department of State: John E. O'Gara
Department of Defense: Dr. H. E. Landsberg
Department of Commerce: Kenneth McClure
Department of Agriculture: Dr. Carlton Barnes
Federal Power Commission: E. Robert de Luccia
General Service Administration: Pere F. Seward
Federal Security Administration: William E. Holy
National Security Resources Board: Jack Gorrie
Atomic Energy Commission: Lawrence R. Hafstad

Mr. ENGLE. Is there unanimity among the departments represented on this committee as to the importance and wisdom of this program?

Mr. LINEWEAVER. Yes, sir. There was no dissent at all with respect to the salt-water provisions. We did not take up the artificial precipitation phase with this committee. It was not named for that purpose.

Mr. ENGLE. Is Mr. Searles going to deal with artificial precipitation?

Mr. LINEWEAVER. Yes, sir. Mr. Warne will open with the salt-water provision and then will be followed by Mr. Searles.

Mr. SAYLOR. Mr. Lineweaver, are these statements which you have just submitted substantially the same as the one which you submitted at the joint hearing of the Subcommittees on Interior and Insular Affairs, Interstate and Foreign Commerce, Agriculture and Forestry before the Senate?

Mr. LINEWEAVER. Yes, sir.

Mr. SAYLOR. And which appear in the printed document?

Mr. LINEWEAVER. Yes, sir. I may say at the Senate committee hearings on S. 1300, and companion bills, they have been printed and I would like to make reference to those hearings for such purposes as the members of the committee may desire.

Mr. ENGLE. The committee has been supplied with copies of the printed hearings from the Senate so to the extent the material is repetitious it will not be included in this record.

What have you submitted? Have you submitted your statement?

Mr. LINEWEAVER. Yes, sir.

Mr. ENGLE. Now, we are ready for Mr. Warne. Mr. Warne, I see you have a prepared statement. Are you able to summarize that or do you want to read it?

Mr. WARNE. I believe I can summarize it, sir, and refer to parts of it and probably cover it more rapidly in that way.

STATEMENT OF WILLIAM E. WARNE, ASSISTANT SECRETARY OF INTERIOR

Mr. ENGLE. Secretary Chapman called me in regard to this legislation in which he expressed a very great personal interest. I have a letter addressed to me dated June 15, 1951. Do you have that letter, Mr. Warne?

Mr. WARNE. I have a copy of it.

Mr. ENGLE. That will be made a part of the record at this point and if you desire you may read it to the committee.

Mr. WARNE. I think that would be a good way of getting a summary before you.

This letter, to which Chairman Engle referred, dated June 15, 1951, and addressed to him, reads as follows:

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., June 15, 1951.

MY DEAR MR. ENGLE: Confirming my conversation with you concerning the legislation H. R. 7 which has been introduced by Mr. McKinnon, and my interest in its subject matter, I regret exceedingly that it will not be possible for me to meet with you to express my views of approval of this legislation, which are well known to you.

My interest in H. R. 7, as well as in the companion measure S. 5, in support of which I presented testimony before the Senate committees on March 15, 1951, stems from my acute realization of the need for additional fresh water not only in our western areas but for many of our Atlantic and Gulf coast cities as well. The abundance of salt water at our shores has led me to the conclusion that it probably provides the ultimate answer to our water-shortage problems. I feel that it is a fortunate combination that has been reached in this measure under which research and demonstration will be undertaken to show that water for human use can be derived both by converting salt water directly where it can be used and by inducing more moisture from the skies to fall upon our land. While I have advocated for some years the salt-water-conversion feature of the bill, I am nevertheless interested in the artificial-precipitation features as well.

Fortunately, we are not entirely destitute of water in any land area of the United States; we are not yet down to the "last water hole." But the problem has reached serious proportions, and President Truman has recognized its importance. A year ago he requested me to take the lead for the Federal agencies in presenting this matter to the Congress with the view of securing legislation authorizing research and development for the conversion of sea water into supplies for agricultural, industrial, and other beneficial consumptive uses. The President also requested the cooperation of the Secretaries of State, of Defense, of Agriculture, and of Commerce, the General Services Administrator, the chairman of the Federal Power Commission, and the Federal Security Administrator in this endeavor. I am happy to report generous cooperation from them and from others, including the chairman of the Atomic Energy Commission and the National Security Resources Board, and the Association of Land Grant Colleges, particularly those located in the West.

Today, demonstrations have shown that it is possible to purify sea water by various methods. Nature's method of replenishing water supplies, of course, is by evaporating moisture from the ocean and precipitating it on the land. Man can imitate or supplement this natural process in several ways. He can increase precipitation from clouds by use of silver iodide, or ice pellets, or he can tap the ocean source directly, ridding sea water of unwanted salts by distillation, by chemical and electrical processes, or by freezing out fresh ice crystals.

Hon. CLAIR ENGLE,
Chairman, Subcommittee on Irrigation and Reclamation,
House of Representatives, Washington 25, D. C.

Many well known commercial and engineering firms have designed and constructed distillation equipment of large capacity for use where no other source of water is available, such as on certain islands in the Caribbean and in the Pacific. The cost of water produced by the most economical of these plants is about $1.65 per thousand gallons when both cost of operation and capital investment are taken into account. This is still far too high for irrigation or municipal use in our continental areas. In short, at present we have the salt water technique at about the stage we had the synthetic fuels industry in 1935 in this country. Some processes were available abroad, none had been developed to the point of economic production in this country and much research was necessary. Nevertheless, in 1944 the Congress authorized the expenditure of $50 million for research and demonstration, and a pilot plant has been constructed in western Colorado in which the production of synthetic fuel is now an accomplished fact. Right now the Navy is getting enough fresh water from the ocean to supply 7,000 men on ships, and I am confident with improvement in methods and expansion of capacity, thinking technical people will be able to reduce the present cost of reclaimed salt water to a figure within the economic reach of municipal and irrigation interests.

I am very hopeful indeed that the committee will report this measure out and the Congress will enact this legislation or its companion measure S. 5 within the near future, as I feel sincerely that the results of this research and demonstration will contribute materially to the defense of our nation as well as to its civil economy.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

Mr. Chairman, that is signed by the Secretary of the Interior, Oscar L. Chapman.

In the interest of saving your time, Mr. Chairman, I might submit my statement for the record and highlight it and then let the questions guide the discussions that might follow.

Mr. ENGLE. That will be agreeable.

Mr. WARNE. Mr. Chairman, I am pleased indeed that you have invited me to present views on H. R. 6 and H. R. 7, which, in simple terms, provide for research and demonstration on two fronts. The first of these relates to methods for conversion of saline waters to potable uses, and the second to methods of inducing precipitation artificially.

Secretary of the Interior Oscar L. Chapman, although he could not be present today, is deeply interested in these matters. His statement appears beginning on page 78 of the printed hearings of the joint hearings on weather control and augmented potable water supply held by subcommittees of Senate Committees on Interior and Insular Affairs, Interstate and Foreign Commerce, and Agriculture and Forestry in March and April of this year. Under Secretary Searles and I will cover much of the same ground here.

The Department of the Interior, on behalf of the United States Government, has major responsibilities for developing and conserving the Nation's water supply. This responsibility has been exercised for many decades through the research and basic data collection of the Geological Survey and over the last half century through reclamation programs for irrigation, domestic and industrial water supplies, and hydroelectric power production, particularly in the arid and semiarid West where the United States is the owner of vast public lands. In other Interior programs, use of water for recreation, wildlife preservation, and related purposes is included.

We are concerned, however, not only in the continental United States, but in our Territories and insular areas as well. After all is said and done, our programs must be directed to that greatest of all objectives—service to the people.

The population of the world is increasing at the rate of nearly 24 million persons each year. The population of the United States is expected to rise to a total of 175 million persons by 1960, and American cities, particularly in the coastal areas, are growing rapidly. Water problems are being created involving use for domestic, industrial, and agricultural purposes that did not earlier appear.

Water shortages have become acute in areas throughout the world and interest in this subject has been heightened. In countries where the greatest concentration of the world's population is found in extensive regions that are arid or semiarid, these shortages are more severe, of course, for there water is needed for irrigation for the production of agricultural crops.

In our own country, some 750 million acres, or more than one-third of the total area of the United States, are in that region requiring irrigation

to support sustained agriculture. Of this area, only about 25 million acres are now irrigated, and hundreds of thousands of these acres are being kept in production only through serious overpumping of existing ground water. Awaiting only irrigation water are millions of acres of fertile soil which can be transformed into highly productive farms supporting greatly increased population in rural as well as urban areas. To maintain good standards of living in these areas, we must supply more water to fertile acres through irrigation.

I think I foresee in humid regions of our country in the decades ahead a great growth of supplemental irrigation to assure and increase crop production. In an unplanned way, this is already starting. The influence it may have on the growth of the United States may eventually exceed that of irrigation in the West. It is sure to create water problems, however, in added areas; problems that will be demanding of solutions one day as difficult as any we now face.

In the West, the expansion of irrigation will provide markets for manufacture and other productions of other sections of the country through increased purchasing power. It is evident, therefore, that an urgent national need exists for constructive action. We can foresee little more than doubling the presently irrigated acreage in the West through projects likely to prove feasible on standards that presently are considered reasonable.

The problem created by the pumping of ground water for irrigation is growing in difficulty. In some of the most highly productive areas in Arizona, California and New Mexico, the pumping rates have been more than twice the safe yields as estimated by the Geological Survey.

In other Western States, overpumping exists to a lesser degree. Throughout these States, the ground water table has been receding from overpumping.

Throughout the Western States, some areas have water supplies which are too salty to serve irrigation, industrial, and domestic uses. This salt may be present in the water from natural conditions or through irrigation use and reuse. This problem can oftentimes be corrected by dilution through mixing with newly developed supplies of fresh water. But dilution requires an abundance of fresh water which is limited in supply in increasingly wide areas. The research proposed in the legislation which you are now considering would include study of methods for removing or reducing the salt content in these areas to a tolerant degree.

Believing that you might be interested in a few actual figures for needs of water, I have a chart on which there have been plotted the present water uses, the natural water supplies, and the future potential uses for each of the five areas in Southwest United States.

On the right is a summary sheet showing the totals of these five areas. These quantities represent averages, of course. On the Rio Grande, the situation is not truly reflected by past averages since, as you are aware, serious water shortages have occurred there in recent years. For example, this year the May 1 forecast is for 30 percent of normal inflow in Elephant Butte Reservoir. On the chart, the blocks in blue represent present consumptive use of water in each of the areas.

The red charts represent the total natural-water resources in the areas, while the blocks in green show the total potential uses for irrigation and municipal purposes to the extent of our present knowledge. The green block was derived by computing the amount of water

required for all known arable lands in the respective areas and for the present population.

In short, the figures represent known potential uses and therefore may be somewhat less than the ultimate total if some additional arable lands are located.

Although the total potential uses shown in green on the chart are indeed impressive, an equally important message is given by the red and blue charts. Here we should pause to consider that in each case the present water use, as shown in blue, now is approaching the total water supply, shown in red. Particularly is this seen in the southern California coastal areas. Here we are already using all of the local supplies and are importing water from the Owens and Colorado Rivers. In the lower Colorado River area, the present uses comprise about three-fifths of the total supplies, and in the Sevier-Bonneville and Lahontan Basin groups the present uses are approximately three-fourths of the total supplies. Since it is seldom feasible to put all water to use in an area, the present water uses approach the maximum feasibly available supply even more closely.

This chart showing the vast potential future water use should not be taken to indicate that we have hopes of supplying all, or even a large portion, of that water by artificial means, nor of irrigating all of the arable land represented by the charts. Rather, if the supplies shown in red can be increased only slightly, the total available useful water will be increased sufficiently, we believe, to justify this program.

Many municipal water shortages have also occurred in our country or are threatened in a number of States where the general welfare of the area would be placed in jeopardy by the development of a serious drought. A critical water shortage made its appearance in the New York City water supply last year while at the same time on the west coast the city of Santa Barbara, Calif., suffered serious water famine. In southern California, Texas, Arizona, New Mexico, and other localities, the rapid growth of population and industry has caused the water demand to exceed the supply, forcing water-short communities to go farther and farther from home to obtain water. Many eastern cities, including New York City, Norfolk, Baltimore, Philadelphia, St. Petersburg, Tampa, Mobile, and New Orleans, as well as Midwest and western cities, are vulnerable to droughts.

In the present national emergency, the need for additional domestic and industrial water supplies in these and other eastern, as well as western cities, may well become definite and pressing.

The health of millions of city dwellers, the safety of billions of dollars in property values, and the general welfare of the Nation will be affected by water shortages which already exist or are threatened in a large number of industrial or urban areas. In many of our island possessions, water shortages exist. In the Virgin Islands, the problem has become acute.

If economical methods of wholesale purification of ocean water can be developed and reliable means of increasing the amount of precipitation can be made available, new frontiers would open not only in the western United States but throughout the world.

The Department of the Interior is constantly alert to the necessity of exploring water-resources potentialities, and we consider the reclamation of sea water and the artificial inducement of precipitation as real and potential sources. Already it has been shown that it is

possible to purify sea water by a number of methods. Nature accomplishes this by evaporating moisture from the ocean, transporting it inland and precipitating it upon the land. Man can supplement this natural process in various ways. He can increase precipitation from the clouds by use of silver iodide, dry ice, and other substances now being developed, or he can tap the ocean source direct, eliminating the unwanted salt by distillation, chemical and electrical processes, freezing, and other means.

When cost can be disregarded, and when the necessity is sufficient, solutions are quickly found. During World War II, the Army, Navy, and the Marine Corps were provided with many compression distillation units for use on islands in the Pacific, the West Indies, and elsewhere throughout the world. Water was provided for hundreds of thousands of United States troops by means of these distillation units.

It has been estimated that one manufacturer alone had sufficient compression-distillation equipment in service at the war's end to supply the daily need of over a million men. Large distillation units have been found practical also for use in nitrate mines in Chile and at Curacao in the Dutch West Indies.

Recently, units for producing three-fourths of a million gallons of fresh water per day have been installed along the Persian Gulf. I have visited installations in the Pacific in the past months for which distillation provided half the needed water.

Where cost is not a factor, distillation has been demonstrated to be feasible. However, such locations are few and even there agriculture and industry cannot rely upon distilled water until lower cost methods have been developed.

Therefore, the problems confronting us in salt-water conversion are largely ones of reducing costs. Manufacturers of the largest vapor compression distillation units have estimated that the water-to-fuel ratio achieved by these units is approximately 200 to 1; that is, 200 pounds of water are produced for 1 pound of fuel consumed.

They have estimated further that the total operating costs including capital investment, would amount to approximately $1.60 per 1,000 gallons. Fifty cents a thousand gallons equals approximately $170 per acre-foot. Our objective is to develop through extensive research and experimentation means for producing much greater quantities of fresh water at fractions of those costs.

Two other promising sources of heat which might be used in purifying water are the nearly untapped energy of the sun and wind power. Great possibilities appear on the horizon for the use of solar and wind energy, and I have no doubt that eventually the tremendous energy imparted by the sun and winds can be harnessed, not only for purifying sea water but for many other beneficial uses as well.

We must face squarely the consideration of long-range plans for the solution of our water problem. These should not be confused by the short-range objectives of local problems.

The short-range objectives such as full use of Colorado River water and settlement of interstate controversies involving the stream should, of course, be pursued diligently. But, at the same time, we are considering transbasin diversions, demonstration of the reclamation of sea water, and artificial inducement of precipitation.

Practicable sea-water reclamation, if achieved, would, of course, provide an unlimited inexhaustible source of water supply from the oceans.

I look upon the research as productive of much more than a little additional water for peacetime uses. It may be possible to reduce the cost of salt-water purification by developing methods for extracting commercially valuable ingredients from sea water as a byproduct. Many of the elements and their derivatives present in sea water are now classed as strategic materials in short supply.

Some of the materials present are chlorine, sulfur, magnesium, bromine, and strategic acid derivatives. Although the chemical industry has developed methods for extracting certain materials from the ocean, pure-water production has not been their objective. Consequently, it has not been possible to take advantage of the shared costs that would result from a process for producing water while at the same time producing chemicals. I am informed that some manufacturers have developed high-temperature equipment which might prove capable of separating certain products while producing fresh water.

Some of our friends in the Department of the Navy have shown that there is enough waste steam from existing plants in our large coastal cities that could be put to use to attain very appreciable reduction in the cost of distilling sea water. It has been estimated by some that it might be possible to provide an emergency supply by this means for large cities like New York.

I am happy to report that my associates in the Department of the Interior, who have been surveying these two fields in preparation for any work program which the Congress may direct with respect to salt-water conversion and artificial precipitation, have reported closest cooperation with the Department of Defense, the Weather Bureau, and other agencies working in these fields. As with many efforts today which serve both military and civilian purposes, we must undertake a balanced program such as to maintain, over a long period of time, the basic economy of our country, upon which the sustained defense program that we now face must ultimately depend. As a means of accomplishing this purpose, I urge enactment of H. R. 6 or H. R. 7 with provisions for greatly accelerated programs of research and development in both of these fields.

Development of economically feasible means of producing from saline waters or from artificial precipitation, water of quality suitable for beneficial consumptive use, will benefit millions of persons. The proposed large-scale distillation of salt water of our oceans and of our inland areas as well presents an opportunity which challenges not only the imagination but the scientific resources of the Nation.

I have no doubt that we can meet the challenge. The Department of the Interior is prepared to coordinate the research activities of all Federal agencies with respect to salt-water conversion. The skills of our scientists of the Federal Government and private industry will be brought to bear on the problem of economic feasibility. The objective will be to develop the best and most effective methods, after which a pilot plant will be constructed to demonstrate the results.

I urgently recommend the immediate enactment of H. R. 6 or H. R. 7.

I am particularly pleased to be here representing our Department on bills that have been introduced by Congressmen Phillips and McKinnon, who represent the two districts in which I spent most of my life in California, having been a resident of the Imperial Valley in my boyhood and more recently from San Diego; I have familiarity with some of the problems that make them interested in this kind of legislation.

The chart on the holder with the blue, red, and green will give you an impression of that problem graphically. It will impress the need for consideration of some method of providing new water supplies, particularly in the Southwest.

On the middle chart you will see the drainage basins of the Southwest outlined with a dark line.

These are the Rio Grande, which is shown only above Fort Quitman, which accounts for the peculiar shape of it in New Mexico, Texas, and Colorado; the lower Colorado, which is that area lying below, as you all no doubt know on this committee, the dividing line at Lee Ferry, the Sevier and Bonneville Basins, the closed drainages that drain toward or into the Great Salt Lake; the Lahontan, Owens, and Mohave Basins, which include the closed basins in Nevada and southern and eastern California.

There are many of these closed basins in the district of our chairman, Mr. Engle, here and the southern California coastal basins, which include those short streams that empty directly into the Pacific.

Now, the charts relate to these various basins. You will notice that in the Rio Grande there are at present 2,500,000 acre-feet of water in use, 2,900,000 acre-feet available, which means that there is a slight unused supply there, and present identifiable needs, including those that have been developed, are 4 million acre-feet.

That means that if the water were available, needed uses would immediately take it up at this time.

I will move on to the Sevier, Bonneville area and you may see from the chart 1,759,000 acre-feet presently used, 2,486,000 that is deemed available for use, and a potential use of 6,254,000 acre-feet.

In the Lahontan, Owens River-Mohave River Basins, 1,700,000 acre-feet used, 2,500,000 plus acre-feet available, with a tremendous potential use of 23 million plus acre-feet of water.

In the lower Colorado River Basin, one which is of critical and vital interest to all of us here, the present use is 5,028,000 acre-feet, the available supply under the 1922 Compact is 8,500,000 acre-feet, as shown here on this chart, with a potential use of more than 31 million acre-feet.

The southern California coastal areas include the present water use of 1,559,000 acre-feet, with an available supply, including the capacity of the Colorado River Aqueduct, of 2,624,000 acre-feet and a potential use that is identifiable at this time of 4,256,000 acre-feet.

These long charts over on the right-hand side, the long bars, show that 12,111,000 acre-feet of water is used presently in the Southwestern River basins, with 17,614,000 acre-feet available for use, and for such additions as regardless of cost that may later be made, and a potential use that could be identified and related to land and to cities and their anticipated growth of something over 68 million acre-feet of water.

That, it seems to me, gives the background, the back-drop against which discussion of experimentation of the two types that we have proposed here certainly warrants the most serious consideration of the Congress.

Now, leaving the Southwest just for a minute, let us see what the situation generally is in the country as a whole.

We were shocked into realization that many of our large industrial cities in areas that we term "humid" might be faced with a situation like those that we have grown accustomed to in our West arid regions, when the great city of New York found itself short of water a few years ago, at a time when the general rainfall in that area was only fractionally less than normal.

The situation at New York was intensified by the fact that a project that had been undertaken before the war was stopped during the last war and was not completed in time to take up the growth that occurred immediately during and after the war and also by the fact that a new element of water use had been introduced up there; namely, air-conditioning, which put an unexpected heavy draft upon the water supply. They were short—not short of water; that could be obtained, but short of water that was immediately available; and other cities are skating near the edge.

It would not take a great drought to cause critical conditions in many of our eastern seaboard areas, and in some middle western areas as well.

We are used to living with water problems in the West where the aridity is a presumed fact and it is taken into account in all calculations.

We are not used to living with a water ceiling in other areas of the country, but that ceiling is inevitably there. As we have grown and developed and introduced new methods and new reasons for using water, we have grown closer and closer to times when that ceiling will become an effective limitation. So all parts of the country are interested in this problem.

Mr. CRAWFORD. Will the Secretary yield for a question there?

Mr. WARNE. Yes, sir.

Mr. CRAWFORD. Is there a single city in the country located off the shore of the Great Lakes that does not have a rather serious fresh-water-supply problem?

Mr. WARNE. I don't know of any at the moment. I know of some that have more severe problems than others.

Mr. CRAWFORD. I agree with you on that, but you take St. Louis, Kansas City, Dallas, Fort Worth, Tulsa, Okla., Pittsburgh, Pa., Philadelphia, Baltimore, New York City—I don't know of a one in the country outside of those located on the Great Lakes that isn't eventually facing a terrific problem with respect to fresh-water supply.

Mr. WARNE. It is not only large cities; in west Texas, for example, there are scores of small communities that have equally serious problems.

Now these are not at this time problems that we are going to have any difficulty in solving. They simply mean that we go a little farther for good water at a little more cost and expense. In this part of the country that is well watered that will be the situation. In the West, where local water supplies have been pledged to current uses,

the situation grows increasily difficult and we look very far afield indeed for new sources, and we are at a point where this kind of consideration of new methods seems imminently desirable.

Now to go to the islands, such as the Virgin Islands, and some of the Pacific islands in which we now have growing responsibilities and we are already at a point where we haven't any visible water supply on which to draw. Salt-water reclamation seems to be the only solution presently available.

I was on one of the Pacific islands within the last 6 months. There was a considerable installation there. Over 50 percent of the water in use on that island was at that time being reclaimed from the sea at a considerable expense, too, much more we think than would be the situation after large-scale demonstrations provide a means of bringing down these costs with pilot-plant operations.

Now I may very well have skipped something in this hasty review of the statement that would have interested you.

Mr. MURDOCK. Mr. Secretary, that is a startling graphic presentation on that chart. Can you undoubtedly justify that tower of Eiffel on the extreme right, marked pale blue, if that is the color?

Mr. POULSON. That is green.

Mr. MURDOCK. Is that green? All right. I am color blind.

Do you think now you can justify that?

Mr. WARNE. Yes. I think that can be justified. I can't at the moment start reeling off the section numbers that would be involved, but our people believe that there is land that would be arable if we had water available in these areas that would warrant the use of water in that quantity.

Mr. MURDOCK. I don't doubt it at all. I just wanted to see what your answer would be on that, Mr. Secretary. I can't see the figures from here. Do I understand that that right-hand chart indicates about 68 million acre-feet?

Mr. WARNE. 68,688,000.

Mr. MURDOCK. Nearly 70 million acre-feet of water?

Mr. WARNE. That is right.

Mr. MURDOCK. My other question is this; that is, for the entire area that you have outlined on the middle chart those half dozen bases?

Mr. WARNE. That is right.

Mr. MURDOCK. Is that potential use for irrigation, or is it for industrial use in the cities that will grow up?

Mr. WARNE. It is for both. There are some industrial uses, for example, such as the anticipated development of the oil-shale industry, which is in an arid area, and also the growth of cities included in that estimate, but normally for nonindustrial cities the water use does not go up greatly as the area is taken over for houses from the fields.

Mr. MURDOCK. That is what I was going to come to next.

You heard the colloquy a moment ago which was unrehearsed between Congressman McKinnon and myself, in which he seemed to think that the increase in population is the cause of the increasing water problem, and I thought it was rather the matter of the enormously increasing use of water for industiral purposes that might be the chief cause.

Mr. WARNE. I think certainly that is the chief cause, though I would remind you that when a new use of water, such as air condition-

ing, suddenly takes hold in an area, it can do some fantastic things to our accepted averages on the amount used per household.

Mr. MURDOCK. I can understand that well. For a long time, if not today, Phoenix, Ariz., was the air-conditioning capital of the country and it is a peculiar kind of air-conditioning. It is pouring water over a mat that permits the fan to suck the dry outside air through it to cool it for the interior.

Now that required great volumes of water. Every hut, every small home, has at least the air-conditioning equipment in a window. That means a garden hose must play on the mat to keep it damp.

In our larger establishments, hotels, and so forth, if they do not use refrigeration they must have their own well from which they draw their water, and they ought to be required to put that same water back in the ground and use it over and over again.

That is certainly true. I hope the committee gets this idea, which I think you stated and did not elaborate on, that if you take a given agricultural area now irrigated that requires so much water—4 acre-feet per acre annually—and convert that into urban areas, that you merely take the supply of water that was used for irrigation and put it to another use, the supply being about the same in either case, unit for unit. That is the thing that this committee, dealing with reclamation and irrigation, ought to study. I think it is correct the way I put it, so that leads me to believe that it is industrialization that calls for the greatly increased amount required over that of residential urban areas.

Mr. WARNE. There was a question raised a moment ago about foreseeable costs of the end product of water that might be obtained from the sea water.

In the statement which I have filed, the figure is used of $0.50 a thousand gallons operating cost as we believe technically obtainable at the present time.

Mr. POULSON. Where did you get that $0.50 figure?

Mr. WARNE. That is what some of our engineers who have looked into it believe they might come up with at this time.

Mr. POULSON. Might be, but there is nothing definite?

Mr. WARNE. No. If we knew, for example, that that would be the limit, or that we could certainly obtain it, it might not be necessary to go through the business of building a plant.

Now let me say what we visualize here in this plant. We envisage a plant that would be built in stages, or at least which would test a series of processes so that we wouldn't run all of the experiments at once, but we would try to carry through on a carefully controlled basis, a test of all of the processes that are presently known, and any others that may be proposed, so that when we got through we would know pretty well which one or two of the processes held promise for any immediacy of use.

There is some experimentation going on abroad at the present time and some more that we should try here, I think, than has been tried in our country.

Mr. MURDOCK. Mr. Chairman, may I ask one more question?

Mr. ENGLE. Mr. Murdock.

Mr. MURDOCK. It is the same question in a little different form. I want to clear up my own thinking and this is the man who can do it I

think. I live in the midst of an irrigated area. We will say it has 242,000 acres of land irrigated and farmed and it would like to have 4 acre-feet of water annually.

Supposing that area of 242,000 acres should become covered with a city and thoroughly urbanized. What would its demands then be—a residential city now—I am not talking about a Pittsburgh or industrial city, but a residential city.

How nearly would that 4 acre-feet of water annually per acre of surface come to satisfying its urban requirements?

Mr. WARNE. On a rule of the thumb, you could say with some confidence that it would satisfy the requirements, the same amount.

Mr. MURDOCK. The same amount of water used for irrigation or for urban?

Mr. WARNE. That is right. Those may have to be changed as new uses of water come in and I suppose they ought to be varied in climatic areas, but in our experience in calculating water requirements we haven't been far wrong in using that rule of thumb.

Mr. MURDOCK. One more question. If the city that I speak of should become a great manufacturing city, now what about the problem?

Mr. WARNE. I think it would depend pretty much on the type of manufacturing that went in there. Some of them use great quantities of industrial water and some use less. I would like to have the opportunity of having our people check through on a couple of typical industrial cities in giving you an estimate for the record on it. I think we can do that.

Mr. MURDOCK. Thank you.

(The information is as follows:)

Information on total water requirements, by cities, is not readily available. Statistics of municipal water systems do not include all industrial requirements, which are in large part supplied by industry itself. It has been possible, however, to obtain an approximate estimate of 1949 average annual water requirements per gross acre in the cities of Houston, Tex., and adjacent industrial area, and Akron, Ohio. For Houston, this estimate is 2.1 acre-feet and for Akron, Ohio 2.5 acre-feet, excluding public-utility steam power generation. 1949 average annual water requirements for irrigation in the rice fields near Houston were 2.3 acre-feet per acre from pumpage and 1.3 acre-feet per acre from rainfall.

It should be stressed, however, that industrial water requirements vary tremendously depending upon type of industry, climatic conditions, and the necessity for conserving water. Statistical data, therefore, should only be used with extreme caution and with a complete understanding of local factors affecting water requirements, use, and supply. Even among plants in the same industrial classification, there may be considerable variation. One of the most unusual examples is the Fontana steel plant, which is located in a water-scarce area. With an annual output of 1,200,000 ingot-tons, water requirements are 3.6 mgd, or 2.8 acre-feet per acre per year on a plant area of 1,400 acres. If the national average of water requirements for the steel industry were applied to the Fontana plant, approximately 215 mgd would be needed.

Mr. BOW. Mr. Chairman.

Mr. ENGLE. Mr. Bow.

Mr. BOW. May I ask you a few questions?

Mr. Secretary, I would like to preface my questions by saying that it may seem unusual that I find myself in complete accord with the Secretary and Department of Interior in this matter and I would like to do what I can to help work it out.

Mr. WARNE. Thank you.

Mr. Bow. The per capita use of water generally is recognized at about 8.5 gallons a day is it not?

Mr. Warne. I think that is the average that people who use the slide rules say.

Mr. Engle. Say that again please.

Mr. Bow. About 8.5 gallons per day per capita.

Mr. Bennett. No; about 150, on an average.

Mr. Engle. Will you ask the question again, Mr. Bow?

Mr. Bow. What I was inquiring was the per capita use per gallon a day.

Mr. Engle. Let us get this witness' name.

Mr. Bennett. N. B. Bennett, Bureau of Reclamation.

STATEMENT OF N. B. BENNETT, BUREAU OF RECLAMATION

Mr. Bennett. If you are talking about the use by an individual himself, that is approximately correct as an average. On an over-all basis, for municipal use, the figure is between 100 and 150 gallons per capita, which includes your industrial uses.

Mr. Bow. Then that would fluctuate some by reason of the industry within the area?

Mr. Bennett. Yes, sir.

Mr. Bow. I am correct in the figure that there are 325,851 gallons per acre-feet?

Mr. Poulson. 326,700.

Mr. Bennett. I think that is correct, 326,700.

Mr. Bow. My figures are bad this morning.

In the Secretary's letter that you read you said that you were in hopes that you could bring this water within the economic reach of irrigation municipalities, et cetera.

Have you considered what the price would be per acre to bring it within economic reach?

Mr. Warne. We know what some areas presently are paying for some water. Now I think one ought to realize that if you need just a few more acre-feet for an economical farming operation, for example, you can afford to pay more than if you have to get your whole supply from that source, but let us take the county in which Mr. McKinnon's district lies, for example. They are paying approximately $44 an acre-foot for certain water that they are using in San Diego at the present time and it is one of their principal sources of supply.

They are seriously considering a dam on one of the remaining intermittent streams that has not been developed which would cost about $45 an acre-foot for its supply.

They have a dam that was begun years ago and abandoned for one reason or another which they are now actually in the process of rebuilding which will provide some water for $28 an acre-foot.

There certainly are places in that country where water is being pumped for avacado groves, for example, at greatly more than $45 an acre-foot.

Mr. Bow. Can you give any idea of the averages?

Mr. Warne. The average is probably under $10 in the whole West. In southern California, the average is probably about twice as high as it is in the other parts of the West.

Mr. Bow. I have a figure of the Metropolitan Water District; it is charging $10 per acre-foot for untreated water and $20 per acre-foot for softened water.

Would you feel for this type of operation to be feasible they should come pretty close to meeting figures now being used out there?

Mr. WARNE. Not if we think of it as augmenting the supply of a city that is critically short. Then I think you could certainly go comfortably to $50 an acre-foot.

Mr. BOW. Is it true that present estimates of experiments that have gone on now show it would run around somewhere around $500 an acre-foot?

Mr. WARNE. I think some of them are actually producing water for that on some of these islands at the present time. We think that cost can be brought down to half that with present knowledge.

Mr. BOW. That is with the use of the turbines and steam and generating plant?

Mr. WARNE. Let me read a paragraph out of this statement that I filed here a minute ago. This refers to the problems confronting us in salt-water conversion being largely ones of reducing cost.

[Reading:]

> Manufacturers of the largest vapor compression distillation units have estimated that the water-to-fuel ratio achieved by these units is approximately 200 to 1. That is, 200 pounds of water are produced for 1 pound of fuel consumed. They have estimated further that the total operating cost might be as low as $0.55 per thousand gallons, whole total costs including capital investment would amount to approximately $1.60 per thousand gallons. Fifty cents a thousand gallons equals approximately $160 per acre foot, * * *—.

so according to those estimates that we have received from the manufacturers it would be about three times $1.70 to bring you out with a best present estimate of cost for providing an acre-foot of water from this source.

Mr. BOW. Your $1.60 per thousand gallons would run about $520 per acre-foot?

Mr. WARNE. That is right; pretty close.

Mr. MORRIS. May I ask one question?

Mr. ENGLE. Mr. Morris.

Mr. MORRIS. Mr. Secretary, you mentioned something about processes. Are there other specific processes you might indicate other than the process of distillation that are or might be feasible in sweetening salt water?

Mr. WARNE. I would like to refer that to Mr. Bennett. He is the engineer who has been doing this work.

Let me say yes, there are other processes, and let him expand a little bit on that.

Mr. MORRIS. We don't want to get too much into that, but we are talking about distillation and that so far doesn't appear to be feasible because of so mush expense involved.

Mr. BENNETT. There are many other known methods at the present time, Mr. Morris. One which is in fairly common use is the ion-exchange method. You find that in many of your home softeners, your Zealite processes, are an ion exchange.

There are processes being developed now under naturally favorable heat balances. There is quite an installation going in North Africa where they utilize the difference in the water temperature in the ocean

between the surface and the great depths that they have at that particular spot, getting their distillation effect, if you will, through that difference in the natural temperatures.

There are methods of freezing that we know can do the same job. It can be done by electrolysis. It has been done experimentally by ultrasonic means. That hasn't been explored to the point where I can tell you anything more than perhaps just the name.

There are special mechanical methods. There are certain gels which can be used to absorb water vapor off the surface of the ocean, for example, and then through heat made to give up those vapors.

I think maybe that will give you a rough outline of what we know at this time.

Mr. MORRIS. Then just this final question, because I do not want to labor that point, although I think it is of extreme importance.

Do you think that it is possible that one of these methods might be used in preference to the distillation process and that if that method could prove successful in actually sweetening the water, that it might be far more feasible and far more economical?

Mr. BENNETT. That is entirely possible. We know at the present time that one of the major factors in the distillation process is the cost of fuel, either as fuel such as oil or coal, or in terms of electrical energy. That is a very difficult item on which to reduce the costs.

There are certain means, not fully explored yet, such as solar energy, which might have a great effect on reducing costs of power for that purpose.

We know very little at the present time on the cost of the other processes. We do know, for example, on ion exchange, however, that it is a direct cost of the chemicals and, presently, on the present price of chemicals it runs about $8,000 an acre-foot which is completely out of reason.

Mr. SAYLOR. That is $8,000 an acre-foot?

Mr. BENNETT. An acre-foot.

I was privileged to watch, about a year ago, an experiment in this ultrasonic process of knocking the salts out of water. It is quite amazing. The water flowed through a glass tube and through a high-frequency field and the salts came out the bottom and the fresh water went on.

Don't ask me what happened. Even the man with the process didn't know what happened. He didn't have the money to carry on his research to determine what happened, but there is something that may have a great deal of merit, so you are entirely correct that perhaps out of this would come a method at the present time not even thought of.

Mr. MORRIS. Thank you.

Mr. ENGLE. May I ask this question: All, or most all of the experimentations that have been done in this field have been done by private resources; have they not?

Mr. BENNETT. That is correct.

Mr. ENGLE. Is there any reason to believe that research by the Government, as provided in this bill, would be more effective than research by private agencies?

Mr. WARNE. Well, Mr. Chairman, I would like to point to the success, again, of the oil-shale demonstration. It isn't so much that

additional new or better research has contributed in such a process as that on a demonstration basis, with careful control of all contributing costs, we have perfected the processes that have been known to be technically feasible. We have run out a demonstration that will make the whole process available to the public.

In the synthetic fuels field, for example, I think the basic scientific facts were known in advance of any work by the Government, but the Government has reduced the costs of obtaining the fuel from the shale, at the Rifle plant, through several different means.

One means was developing and introducing specialized equipment for the mining process; another means was actually carrying through the scientific work that had been begun by others and developing new methods of applying the scientific process so as to cut right square in two the costs of the equipment and its operation. The equipment used only in the laboratory before was not efficient. I think there are many avenues here which warrant the consideration of the Congress today, the avenues of carrying through, of proving up or of shoring up the processes that are known, but on which no one acting as an individual could afford to put the necessary perfection work that we feel now promises to bring forth good results.

Mr. ENGLE. Well, I can understand how if we are going to operate a proposition on a pilot-plant basis that perhaps the Government ought to be the agency to do it, but when you are in a field of scientific research I am not so sure that the Government is the best agency to do it.

My hunch would be that you might do better if you went to some of these universities or private agencies and contracted it out.

Mr. WARNE. That is the precise reason that we have provided in here that the Secretary could work through—in subparagraph (d) of section 2, the Secretary would—

> be authorized to engage by contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work.

It is certainly intended and expected that those parts which reasonably could and should be farmed out to educational institutions with research facilities, would so be farmed out under this section.

Mr. ENGLE. I know the bill does authorize that and it does not require it, but I am just turning this thing around in my head. It seems to me that you would have to build an organization of scientists yourself; you hire the people who are already very actively in this field and who have done considerable work with it.

When you get to the point of running a pilot plant I think the Government should do that, or else give somebody the money to do it.

If you do that it does not take too much in the way of scientific research skill and it can be done by the Government; the testing out of processes and their economics, that have been shown to be workable in the laboratory, in other words, but as far as laboratory work is concerned, I am suspicious of Government.

I don't believe that the Government can do it and I think the probabilities are you can build yourself a vast edifice of employees and what not and it probably would not be as efficient.

Mr. WARNE. Well, it isn't the intention here to say we are preempting this field. The intention is to bring into a central demon-

stration and research center all of the skills and all of the processes that could be made available for the purpose of giving us a good full-scale demonstration of the economics and the feasibility of the experiments.

Mr. MURDOCK. Mr. Chairman.

Mr. ENGLE. Mr. Murdock.

Mr. MURDOCK. I wonder if the Secretary's expression that this can best be done by cooperation, by farming out, as you say, some of the work to experts in industry or in our great educational institutions, should be further considered. I certainly do agree with that.

I wanted to say specifically this: I do not know that there is any member of the committee now, other than myself, who was on the committee 10 years ago but, if you will pardon it, I want to refer again to the pioneer work that was done in this committee 10 years ago in regard to conversion of coal and other such things to liquid fuel.

At that time we had a great store of German patents that had been taken over as war property and we held extensive hearings in this committee, to see whether there was some German patent that we could use which had been used in Germany prior to the Second World War, but we heard experts, and a subcommittee headed by Jennings Randolph, of West Virginia, went into the matter thoroughly and I recall that the first authorization of $30 million to set up a pilot plant was made; but at that same time we understood there was a pilot plant being operated to convert coal into liquid fuel, but it was pointed out that our diminishing oil supplies warned us to get busy, and that while industry was working on it the Government itself ought to work on that problem, and it did.

For that same reason I think that although industry needs to do this thing, it needs to be supplemented by the Government itself, and that before the need becomes so acute that it is too late to start.

Mr. SAYLOR. Mr. Chairman——

Mr. ENGLE. Mr. Saylor.

Mr. SAYLOR. Mr. Secretary, apparently one of the big items that has been your problem up to now is the matter of cost; is that correct?

Mr. WARNE. That is right.

Mr. SAYLOR. And I gather from your statement, which you have filed here and read from, on pages 7 and 8, it is indicated that in the present distillation method the biggest item is not fuel but the biggest item is capital investment.

In other words, you say there might be as low as 55 cents per thousand gallons, while total cost, including capital investment, would be approximately $1.60, so that the capital investment in this situation would be twice as much as the fuel cost.

Mr. WARNE. Capital investment and also operations cost.

Mr. SAYLOR. That is right.

Now, according to Mr. Bennett, he named six other methods rather than distillation and the ionic change he said would be approximately $8,000 an acre-foot.

Mr. Bennett, are you in position to give us, if you know, the approximate cost today on any of these other five methods per acre-foot?

Mr. BENNETT. Electrolysis, which I mentioned, will run about $300 an acre-foot, if you can get power at 5 mills.

Mr. SAYLOR. That is just the cost, or is that the total involving capital investment?

Mr. BENNETT. That includes capital investment allotment also. Most of the others we don't have any costs on.

Mr. SAYLOR. All right. Now then, according to your statement, Mr. Secretary, your object then is to find means of producing greater quantities at fractions of the cost. In other words, you must have some target at which you are shooting as far as price is concerned. What is that?

Mr. WARNE. Well, I should say that the target would be something like slightly below the costs of water that is presently the sources of the western cities. That would be $50 an acre-foot, or below.

That won't do for agricultural use. It has got to get down to something a good deal lower than that before you have any prospect of large scale irrigation.

Mr. SAYLOR. In other words, industrially you are shooting for something below $50 an acre-foot?

Mr. WARNE. That is right. There are other situations in which we are interested. For example, as we approach the end of the available water supply in any stream, and use it and reuse it several times, the quality of that water diminishes.

In other words the water has more and more soluble salts in it as you get closer to the final use of the water. We will have definitely a quality-of-water problem in the future that will match, I think, your quantity-of-water problem of today on many of the western streams.

Mr. SAYLOR. In other words, you think it is going to take more and more water to wash out the soluble salts; more of the presently available supply?

Mr. WARNE. As you use the water over and over again, it will dissolve more and more solids, so there will come a time when we approach the limit of tolerance at the downstream point of use.

Now if we can develop a process which will assist in lowering that salt content, it may not even be necessary at all to run into the cost, for example, of reclaiming sea water.

You are dealing with something that is only 12 or 13 or 14 hundred parts per million instead of the intensity of the solution of sea water, so it has a whole wide possibility of application.

You don't have to go clear to the saltiest water in the world in order to come up with a practicable solution.

Mr. SAYLOR. But, Mr. Secretary, would not the plant necessary to treat the water be the same whether or not it be salt water or whether it be fresh water?

Mr. WARNE. I would point out that the present basis of judgment is usually on the little hand-built constructions in laboratories, just as it was when we started the synthetic-fuel investigation. The great savings that have been made and demonstrated in the oil-shale experiments have been on improved plant, on better machines.

No one had designed a machine for laboratory use. They adapted some machine that was available before. It is when you begin the design of the machines for the specific use in large-scale operations that you have the opportunity to bring the cost down and I don't think it would be safe at all to assume that the only saving that could be made would be in fuel.

I think the greater savings are going to be made in better designed plants, reduced cost there. We are still reducing the cost of the plant

at Rifle. That is, we are reducing the cost of the operation there through improving the plant.

Mr. Bow. Will the gentleman yield?

Mr. Saylor. Yes.

Mr. Bow. Mr. Secretary, is it a fact, however, that the plants which were built for the Navy have worked?

Mr. Warne. Yes.

Mr. Bow. Their experience has been such that it shows it is practical?

Mr. Warne. Yes. If you have been at Johnson Island, and took a drink of water, the chances are more than 50 percent you drank some that came from one of these plants.

Mr. Bow. Of course, the great aircraft carriers, and all of them that use hundreds of thousands of gallons of water at sea without a chance of refreshing have been able to use this system so it is practicable to pursue it further.

Mr. Warne. There is no question, I think.

Mr. Bow. And even at $50 in a place like the Virgin Islands or even Puerto Rico, or some of our other islands, it would be a very practical investment, would it not?

Mr. Warne. It certainly would. The cost was not the determining factor at all in the Pacific, for example, either before or after the war.

Mr. Bow. If these territories are to progress and become self-sufficient we are going to have to find some way to solve the water problem for them.

Mr. Warne. Without any question that is true.

Mr. Poulson. I have a question.

Mr. Engle. Mr. Poulson.

Mr. Poulson. The subject you mentioned about the water down in the river is a problem we are going to run into next in connection with the Colorado River, isn't it, if they start using the water up in the Upper Basin and use it two or three times; that salt question is going to be a question of controversy; isn't that right?

Mr. Warne. I think without a doubt it is a problem on the Colorado and it will be a problem on the Rio Grande; it will be a problem on any other stream where the water is used and reused and reused.

Mr. Poulson. Therefore, the purpose of this bill is to further experiments and you are admitting that there is the element of chance?

Mr. Warne. Yes. I think that is true. It may not be possible to prove a process at this time that will do the job for a cost that anyone would think reasonable.

Mr. Poulson. Therefore, all I wanted to definitely nail down—and I am in favor of this experiment and all that—was that in doing this, that does not mean that this is the solution to some of our other problems; mainly, our controversy on the Colorado River between the two great States of Arizona and California?

Mr. Warne. I wish I could tell you, Mr. Poulson and Mr. Murdock, that it was, but I can't.

Mr. Bow. I would be willing to vote for more money for it if it was.

Mr. Poulson. I wanted to know if you thought this was one of the solutions. I knew it wasn't but I wanted it in the record.

Mr. Engle. As soon as we can get a process worked out we will give Arizona the Pacific Ocean.

Mr. Poulson. I have one more question.

I certainly agree with our chairman, Mr. Engle, that there should be a leeway in this bill so that the facilities of our universities and other laboratories can be used where they have made these big expenditures in setting them up, rather than to start out to set up within your own Department laboratories and the like, because that $25 million would go before you even got started working on the problem at hand.

Is that true?

Mr. WARNE. The provision is in the bill and it is our intention too to make use of the facilities that are available.

If all the facilities were available we probably wouldn't need much, but they aren't available at this time and we are going to have to build at least a central plant and demonstration unit.

Mr. ENGLE. Before we go any further, may I say that we will continue these hearings tomorrow and finish with the rest of the witnesses.

Mr. Searles, we are sorry we kept you waiting today, but these preliminary witnesses from your Department were so long-winded that we regarded it as pretty much their responsibility.

However, can you be available the first thing in the morning?

Mr. SEARLES. Ten o'clock?

Mr. ENGLE. If you can we will try to get you on right away and out of here. I know you have other matters.

Mr. SEARLES. I have a Defense meeting tomorrow morning but if I can I will come down at 10.

Mr. ENGLE. If you can't make it at 10 we will put you on when you do arrive.

Mr. SEARLES. Thank you very much.

Mr. ENGLE. I will say to the committee, I had in mind hearing these Government witnesses and then at a later date getting some representation before the committee at least on a sampling basis of the technical men who have dealt with this problem and the private firms, or concerns, which have taken an interest in it, to give us an idea of what the prospect of successful conclusion of this kind of a proposition is.

We should be able to anticipate, I think, to some extent at least what the probability of success is, before we bet $25 million or any part of it that it will be successful, and then it seems to me the committee is going to have to consider the matter of mechanics if it desires to authorize this kind of program at all, and the matter of the mechanical way of doing it and how it should be done.

Have we completed the questioning of Mr. Warne?

Mr. MURDOCK. Mr. Chairman, I would like to ask just one question.

I would like to say that I have sponsored, or encouraged such legislation as this, but not with a view of any bearing it may have on the controversy between Arizona and California. I say that seriously, but this is what I wanted to ask:

Did I understand you to say, Mr. Secretary, that a process that would make water at the lower end of a river, which had become too salty for agricultural use, tolerable to plant life, at a much lesser cost, would be one of the objectives of this legislation?

Mr. WARNE. Yes. We would have in mind the reclamation of brackish water as well as saline water and the practical application

of that would be, for example, sweetening water that had reached the point of intolerance to plants in its soluble salts.

Now we presume—I think with justification—that we can do that cheaper than we can reclaim sea water.

Mr. MURDOCK. Exactly and if so this might be the salvation of an irrigation project that is about to go under because of that increasing salt, might it not?

Mr. WARNE. There are places where the problem is becoming serious and in time it will grow and in my judgment have the same kind of implications as the present quantity of water problem has in various parts of the country.

Mr. MURDOCK. I just wanted to impress on the committee that that is one of the problems of reclamation and that it might be possible to sweeten water that has been used a half dozen times for irrigation and become too salty, at a very nominal cost and not make drinking water out of it.

Mr. ENGLE. Mr. Warne, did you plan on returning tomorrow?

Mr. WARNE. I will come back if the committee wishes.

Mr. ENGLE. Does any one desire to ask further questions of Mr. Warne? If not, we will excuse you and you can come if you desire.

Mr. WARNE. I would like to make one very brief statement. The question was raised about the purpose of the language here that has to do with the water being in the natural streams. That is so that the water right system of the West would not be disturbed by the artificial precipitation of water into the area.

Mr. BOW. Does the question of the purchase of secrets, and so forth have something to do, too, with the security of the Navy?

Mr. WARNE. I think it does and it is also taken together with another section. It has the intention of making available for general use, not limited use, but for general use, nonrestricted licenses of processes that prove practicable.

Mr. BOW. Then your experiment with these would mean it might be necessary for you to use some of the know-how of the Navy which might still be under security?

Mr. WARNE. Or even of some industrial plant that isn't at this time willing to let it out for some reason.

Mr. ENGLE. Mr. Lineweaver, do you desire to put a statement in the record?

Mr. LINEWEAVER. Yes, sir. I desire to submit this statement for the record by Mr. Fairfield Osborn, president of the Conservation Foundation of New York City regarding the desirability of this legislation.

Mr. ENGLE. Thank you very much. Without objection the statement will be admitted.

(The information is as follows:)

STATEMENT OF FAIRFIELD OSBORN, PRESIDENT, THE CONSERVATION FOUNDATION, NEW YORK CITY

Being directly concerned with the conservation of our natural resources, including water supplies, our organization, The Conservation Foundation, is much interested in the feasibility of proposals to promote economical conversion of salt water to fresh.

The use of water in this country, as everyone knows, has increased enormously in the last 25 years. The demand has become so pressing in some places that pumping from certain ground-water reservoirs has been excessive. In some cases

salt water has come in. Other instances of demands for water that cannot be met at present are familiar to everyone. Defense programs call for additional large quantities. There is clearly a need, therefore, to find out whether it would be economically feasible to supplement present water supplies, in areas of great demand, through development of some conversion process.

Of course, this is only one of several possible approaches to implementing our water supply. Studies of ways to increase and control precipitation may be productive. Reducing the pollution of rivers, greater economy and reuse of water by industrial plants, and reclamation of waste water by municipalities are other ways in which our Nation is beginning to make at least some progress. I mention them to indicate that our ———————— has been looking at the problem generally. Let me add that increasing the amount of water available to meet growing demands inevitably involves judging the advantages of one means against another in each area or region, and also involves a number of questions about the ways in which we should manage resources other than water.

With regard to converting salt water, one of the questions involved will be the ultimate source of the considerable energy required to operate a process, plant which may require use of other than conventional fuels. Another obvious consideration is the cost of delivering converted water to the places where it will be used.

With these and other considerations in mind, The Conservation Foundation has committed some of its research funds to a preliminary study of the economic and technical feasibility of salt-water conversion. We are glad to note that the Congress is again considering authorization to enable the Department of Interior to undertake substantial studies in this field. It is clearly in the public interest that this whole question be explored from as many different points of view as possible, in order to determine beyond a reasonable doubt whether it would be advantageous to encourage conversion of sea water on a large scale.

The livelihood of actually tens of millions of Americans in water-short regions with growing populations must be safeguarded by the development, through scientific investigation, of some economical means of increasing the amount of water available at any given place and time, thus among other things making us less dependent on the vagaries of climate. Without doubt, the water problem is an immediate and pressing one for our country.

FAIRFIELD OSBORN.

Mr. ENGLE. Without objection, the committee is adjourned until 10:00 o'clock tomorrow morning.

(Whereupon, at 12:10 o'clock a. m., the committee adjourned, to reconvene at 10:00 a. m., Wednesday, June 20, 1951.)

PRODUCTION OF FRESH WATER FROM SEA WATER

WEDNESDAY, JUNE 20, 1951

HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to adjournment, the Honorable Clair Engle (chairman of the subcommittee) presiding.

Mr. ENGLE. The Subcommittee on Irrigation and Reclamation will be in order for the further consideration of H. R. 6 and H. R. 7.

At the end of yesterday's meeting Mr. Warne had completed his testimony and unfortunately Mr. Richard Searles, Under Secretary of the Interior, who was here yesterday for the entire proceeding, is necessarily absent this morning because of a previous commitment before another committee and I will therefore ask that Mr. N. B. Bennett, Jr., Assistant Director of the project planning from the Bureau of Reclamation, come forward and read Mr. Searles' statement, if he will.

Mr. Searles' statement is rather brief and I think it would be proper for the committee to hear it.

Mr. BENNETT. Thank you, Mr. Chairman. Please bear in mind, gentlemen, that I am reading Mr. Searles' statement.

Mr. BENNETT (reading):

STATEMENT OF UNDERSECRETARY RICHARD D. SEARLES, DEPARTMENT OF THE INTERIOR

It gives me pleasure to appear here before you to discuss these bills, H. R. 6 and H. R. 7. Not long ago I had the privilege of appearing before joint committees of the Senate in the capacity of president of the Salt River Valley Water Users Association considering the companion bill S. 5.

At that time I confined my remarks to the aspects of these bills concerning artificial precipitation with which I have had experience in the Water Users Association. Although I am equally interested in the aspects of salt water conversion, I am not as familiar with that field and shall therefore confine my remarks again to artificial precipitation.

I have considered the question as to the responsibilities which the Department might discharge and the services which it might perform in advancing this new science at an accelerated rate in order that the facts necessary for an appraisal of its practicability may be made at the earliest possible date.

For the past 3 years the Department has followed closely activities in this field. A considerable amount of data on the nature and scope of experiments conducted by various governmental and private organizations have been collected. We have realized for some time the importance of these development to the Department.

From the information obtained so far, we have concluded that a vastly accelerated program of research in atmospheric physics and chemistry directed specifically toward the development of practical means of inducing and controlling precipitation is vitally necessary. A program of needed research has been prepared. Considerable research has been conducted by the armed services under the enterprise known as Project Cirrus.

However, only limited projects have been conducted from which a practical evaluation could be made. The actual work of precipitating rain is relatively inexpensive compared with the cost of evaluation. It is very important that additional field research work on a large scale over a comparatively large area be conducted where extensive work is done on evaluating the results. We have had very good cooperation from the Weather Bureau in consulting them regarding results of the evaluation work which they have made, to the extent that their available records will permit but that work has been quite limited.

I believe sincerely that until such a comprehensive program of research is undertaken, the work will lag far behind the practical application of those facts which are disclosed from time to time. There is considerable optimism in the minds of eminent scientists that methods now available for inducing precipitation can be used to great advantage in this country in controlling weather. There is not any question of the possibility of inducing rain by artificial means but a study of the practical adaptability for commercial work needs the help of a comprehensive and large program to be conducted by a department of the Federal Government.

It has been my experience that there have been doubting Thomases among the scientists but I must say that many of them who were at first skeptical now show a great deal of interest in the work of Scientists Langmuir, Schaefer, and Vonnegut.

Since no agency so far has been charged with the responsibility of advancing this science at a rate commensurate with the needs which drought-stricken areas have for the adaptation of artificial weather-making, I feel that the Department of the Interior should at this time be charged by the Federal Government with the responsibility for assuring that this research is expanded to the limit of the Nation's total research capacity.

Among the valuable resources of our Nation, water takes its place near the top. The economy of our country, particularly that of the Western States with which the Department of the Interior has the closest contact, is dependent very largely upon water resources. Realizing this, I have asked the numerous bureaus within the Department of the Interior for an expression of their views as to the effects which altered rainfall patterns in the United States might have upon the general welfare of the Nation as reflected in their work.

I was deeply impressed to learn that nearly every agency in the Department finds itself confronted with growing problems which have developed as a result of the prospects that rainfall may be adjusted artificially.

The Bureau of Reclamation, for example, is responsible for multiple purpose river basin developments throughout the West. The design and operation of these projects depend for their safety, adequacy, and economic stability upon existing climate and existing water supplies. Any significant change in either climate or water supply will require a complete recasting of the plans for irrigation, power development, and flood control throughout the country.

The Geological Survey has the responsibility for measuring and studying the Nation's water resources including ground water as well as surface water. The evaluation of rain making upon water supplies, floods and erosion will depend to a great extent on the records being kept by the Geological Survey.

It is possible that the network of streamflow and sediment measuring stations and of ground water measurements would have to be revamped to provide adequate data necessary for proper evaluation.

The effects which adjusted quantities of water would exert upon the beauties of our national parks are many. Increased or decreased stream flows and snow packs would cause major changes in some park features, extending to changes in the quantities and types of vegetation. The prevention of fires in these areas by induced rainfall would be a matter of real importance to the protection and administration of the parks.

The Bureau of Land Management is responsible for the conservation management of 170 million acres of arid and semiarid range land in western United States and an estimated 272 million acres of inflammable forest and woodland in the United States and Alaska.

The highly erodible nature of the range lands is directly related to the lack of sufficient precipitation and the erratic nature of its occurrence. Controlled precipitation, if successful, might provide a more adequate vegetative cover on the land and would alter the rate of deterioration through soil erosion on these public lands.

Lands under the jurisdiction of the Bureau of Indian Affairs and the Indians and white utilizing them would under certain conditions benefit from a program of controlled precipitation.

Such controlled precipitation would alter flood crests, change the rate of loss of soil by erosion, and the rate of siltation of reservoirs. These changes might be beneficial or detrimental, depending on a number of factors. The Bureau has responsibilities for nearly 27,000,000 acres of land in the affected area in Arizona, New Mexico, and southwestern Colorado. The Indians of the Southwest are greatly disturbed by the present drought and its continuation this year will bring dire consequences.

A number of the tribes have considered the advisability of contracting for precipitation. The Navajo Tribe in 1950 actually paid $10,000 to a commercial concern for precipitation. The results unfortunately were inconclusive. Reliable information is needed upon which to base decision on the expenditure of tribal funds for this purpose.

The Bureau of Mines is engaged in studies of air pollution and is concerned with the broad subject of nuclei formation and diffusion in the atmosphere. Industrial smokes contain many chemicals, some of which may, as aid pollutants, be found to be effective also in hastening or delaying the formation of rainfall.

The Fish and Wildlife Service now administers in excess of 6 million acres in the Western States where cloud modification is now scheduled under contract with commercial operators. Each of the projects involved has an extensive series of dikes and dams designed to maintain the waterfowl breeding and feeding areas and meet other requirements in managing wildlife resources and operation of fish hatcheries.

Added precipitation during the fall, winter, and spring months would, in most instances, be beneficial. Unseasonable precipitation would, if it fell in excessive quantities or in torrential storms, represent a serious threat to Fish and Wildlife Service installations.

It would also contribute directly to substnatial losses of waterfowl and other wildlife.

The factor of erosion should also be considered. Protracted droughts affect fisheries resources adversely and may change the entire ecology of a stream or lake. In these instances, the induction of artificial precipitation in reasonable amounts would be highly beneficial.

Thus it is evident that the Department of the Interior has a vital interest in the development of this new science. In fact, there is scarcely an agency within the Department that will not be significantly affected.

That is the end of Mr Searles' statement

May I, Mr Chairman, while I am here take just one minute to introduce for the record a brief statement I have prepared, which is also in the Senate hearings and to save time I would merely introduce it in the record at the appropriate point?

Mr. ENGLE. It may be submitted at this point, if there is no objection.

STATEMENT OF ASSISTANT DIRECTOR OF THE BRANCH OF PROJECT PLANNING, N. B. BENNETT, JR., DEPARTMENT OF THE INTERIOR

Mr. BENNETT. We have given considerable study to the general organization and plan of procedure. The physical research on salt-water reclamation would, as you will recognize, be entirely different in the beginning from that on artificial precipitation.

Later, however, the studies of the increased water supplies and their effects upon water use, projects, and the economy must be tied together, as the one supplements the other.

The two, together with natural water supplies, will comprise one undertaking. I shall discuss the research relating to sea water first, followed by that relating to artificial precipitation.

In sea-water conversion research, it is expected that at least the first year will be devoted to the initial phase consisting of (1) exhaustive review and appraisal of all work accomplished in the past for the

purpose of eliminating obviously unsound methods and to estimate the apparent economic potentialities of the remaining methods; (2) program of limited testing and planning for the improvement of existing methods appearing to have some promise of success; and (3) initial examination and probably design of experiments and research to be undertaken in the second phase.

We feel there should be an advisory board consisting of representatives of different interested agencies whose function will be to advise on the design of the actual program and to participate in the research through their agencies to the extent necessary.

Secondly, consultants will be employed in each of the several fields such as compression distillation, solar energy, ionic exchange, marine thermal energy, wind power, and so forth, as the need for each arises.

The function of these consultants will be to advise, review, and make recommendations on procedures and studies to be undertaken and to assist in appraising the results.

Third, a planning staff consisting of a project director and his assistants who would direct and coordinate all phases of investigations, maintain liaison with cooperatively participating agencies, give technical guidance to all operating units, keep abreast of technical developments, inventory the facilities of the various agencies and organizations, and make recommendations as to the assignment of specific phases of the work to various agencies and organizations.

Fourth, preliminary laboratory investigations will be conducted on known processes of salt-water reclamation which has a possibility of economical feasibility and to explore new methods and possibilities.

The aim of laboratory investigations is to eliminate those processes less worthy of larger scale study; and to obtain preliminary design and approximate cost data.

Investigations would be conducted on the following:

(1) Solar distillation and solar power.
(2) Ion exchange.
(3) Marine thermal energy.
(4) Underground burning of coal.
(5) Electro-Osmosis.
(6) Use of wind power for conversion and pumping.
(7) Utilization of waste heat from atomic energy.
(8) Other methods (requiring preliminary screening):
    Absorption of water
    Freezing
    Ultrasonic purification
    Miscellaneous processes suggested by any contributor as program develops

Fifth, studies will be made on possible pilot-plant activities. This will be limited at present to contracts with private industry for design, operating cost data, cost estimates, and so forth, of large capacity thermal compression distillation apparatus and ion exchange unit. This should provide sufficient details for the construction of a plant available in the event of a potable water emergency, even though the studies would show that these processes could not compete with present sources of irrigation water. This part of the investigations would also include pilot studies on electrolytic methods, development of wind power, and solar distillation methods, but to a more limited extent.

It is estimated that the work of this first phase will cost approximately $700,000 divided about 65 percent among Federal agencies and 35 percent among various private industries.

The second phase should consist of the construction of a so-called pilot or demonstration plant on commercial scales, at a location such as San Diego, Calif., and containing one or possibly more of the methods most promising.

This latter phase cannot be spelled out in detail at this time as exactly what would be done would depend upon the results of the initial stage.

ARTIFICIAL PRECIPITATION

The outstanding need in artificial precipitation is for a yardstick by which to estimate the increase or decrease in precipitation that may be possible to cause artificially. Until this reliable yardstick is provided, the practical effects, which this artificial rainfall pattern will have, can only be approximated. We are fully aware of the studies of practical effects which should be made. For your information, I am including a list of them, which I will not take your time to read. You will note from the list, however, that the new science will affect almost every phase of Water and land use.

The development of a satisfactory yardstick can be along two possible courses. I recommend that the two be pursued concurrently and immediately in view of the urgency and extent of the problems involved.

The first course is the formulation of an interim yardstick or criterion based upon the present available knowledge on the subject from which to make broad general estimates of this possible artificial increase in precipitation.

This should be set high, at a maximum, and as research advances, the upper limit would be gradually reduced. It would also be on broad geographical basis at first, and could be more detailed, covering smaller areas, as research and field tests disclose the actual potentialities in a given area. Although these tentative criteria would prove to be too high at first, at least they will be an improvement over methods which we have today, and most importantly would permit us to begin evaluation of the economic effects almost at once.

A selected group of the Nation's leading authorities on the subject would be called upon to make the best available estimate at present with full recognition that this undertaking would be subject to change and would be made only because of the urgency of the situation.

This might be handled through the auspices of a recognized association of eminent meteorologists, such as the American Meteorological Society.

The second course is to conduct the program of research from which the reliable and accurate facts necessary for making up this yardstick can be ascertained. Simple as this may sound, it involves the whole range of physics of the atmosphere and all research is, in fact, directed toward this one goal.

The physical research necessary to the development of a theoretical quantitative criterion is given in the attached outline, appendix A.

Some of this research is already underway, as you have been advised. The outline, therefore, represents the total deficiency in

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existing scientific data, and it would not be expected that there would be unnecessary duplication.

Some duplication, however, is often desirable in research work in order to assure exhaustive probing of all possible results. In this regard we propose to let quite a number of research contracts to universities, several of which should have the broad objective of exploring the general field without stringent restrictions. We find many brilliant young scientists in these institutions, working with almost no funds, who come up with new and sound explanations of weather phenomena that may escape the more mature and conservative weather researchers.

In addition to the development of these theoretical criteria, field tests of actual effects of cloud seeding are necessary to confirm or modify these criteria. This should be in two parts, first, statistical evaluation of the results of commercial cloud seeding from existing records of precipitation and stream flow. It is recognized that such records in these areas are not often adequate for this purpose and that these evaluations probably contribute least to the development of the science.

They are, however, necessary and in some areas may constitute the only data available. In some cases they simply may not be useful. But such of these studies as are possible must be made not only for this purpose but to solve many other problems, including some inevitable litigation.

Dependable reporting of cloud-seeding operations, and installation of additional records are needed.

The second, and far more reliable field measurements of effects of cloud seeding, will be in the nature of fully controlled tests. These tests must be designed to meet the requirements of a competent theoretical statistician, and field controls must be installed before the experiment is begun. Several such controlled experiments in different parts of the country are needed. I might add that the experiments made in the New York City watershed and those in the Owens River Valley in California are of the type needed. One complete test for areas in the Pacific Northwest has been designed by the Bureau of Reclamation in January 1949. I regret that it has not been possible to conduct this and other similar tests from which you gentlemen might appraise the potentialities of this science and upon which we might begin to reappraise the resource development programs of our country in accordance with the second outline which I have attached to this report.

So far your attention has been directed only toward inducing rainfall. There may be possibilities in certain areas of stopping, temporarily, precipitation on one side of a mountain range and thence inducing precipitation on the other side, thus helping to even up some unbalances. We would expect that this research would disclose whether those possibilities exist and if so, where and to what extent.

Appendix A. Research Needs in Artificial Precipitation

(List is designed to indicate all presently forseeable research needs and includes research undertakings already underway and those not yet initiated.

1. The determination of the physical processes involved in precipitation.
   (*a*) From supercooled clouds.
   (*b*) From clouds warmer than freezing.
   (*c*) By other means.
2. The chemical composition of the atmosphere up to 30,000 feet or higher.
3. The influence of various chemical components upon precipitation.
   (*a*) Influence upon the activity of nucleating substances.
   (*b*) Influence upon precipitation static.
   (*c*) Effect upon coalescence, sublimation, and condensation.
4. The effect of sunlight upon nucleating substances and upon the formation of precipitation.
5. The time-duration effectiveness of silver iodide and other nucleating agents.
6. Development of new types of nucleating agents and means of controlling their life and activity.
7. A study of nucleating agents present naturally in the atmosphere, the nature and sources thereof.
8. The development of improved means of counting and identifying nuclei and nucleating agents in the atmosphere.
9. The extent and rate of travel and dispersion of nucleating agents.
10. The use of dry ice by other means than from airplanes.
11. Determination of the effects which artificial nucleation may have upon—
   (*a*) Rainfall in adjacent local areas.
   (*b*) Weather and climate of extensive portions of the Nation.
   (*c*) Weather and climate of the entire northern hemisphere.
12. Means of deactivating artificial and natural nucleating agents present in the atmosphere.
13. Optimum quantities of artificial nucleation under various physical and chemical atmospheric conditions to (1) produce maximum precipitation; (2) to insure against overseeding, resulting in reduced precipitation; (3) to cause overseeding where desirable.
14. Means of artificially inducing the formation of clouds from humid atmosphere.
15. The development of more satisfactory criteria to determine the maximum increase in precipitation that may be possible artificially.

Appendix B. Outline of Studies of Probable Effects of Artificial Precipitation

I. Changes in water supplies:
   A. In streams:
      1. Quantities and rates.
      2. Season and frequency of occurrence.
      3. Quality (initially increased erosion from formerly arid lands) (reduced erosion eventually from increased grass cover).
   B. Underground supplies.
   C. On crop lands direct:
      1. Quantities and rates.
      2. Season and frequency.
      3. Subsurface storage in soil.

II. Study of effects of changed water supplies on water-use and control projects.
   Existing projects.
      1. Revision of operation schedules using existing facilities only:
         (*a*) Irrigation.
         (*b*) Power.
         (*c*) Flood control works.
         (*d*) Other.
      2. Alteration of existing facilities:
         (*a*) Dams and reservoirs, spillways, storage capacities, power plants, additional reservoirs, flood control works.
         (*b*) Distribution and transmission systems.
         (*c*) New lands made irrigable by I–A and B.

3. Increased direct rainfall on crop land and grazing lands (result of I–C):
   (*a*) Reduction of irrigation demands on existing lands.
   (*b*) Use of excess resulting from (a) on new lands.
   (*c*) Changes in class of crops.
   (*d*) Effects on soil moisture supplies.
   (*e*) Additional drainage problems.
4. Erosion and sedimentation:
   (*a*) Lands.
   (*b*) Channels.
   (*c*) Canals.
   (*d*) Reservoirs.
5. Effect on parks and on fish and game.

B. Revised basin plans:
1. Altered diversion demands due to reduced crop demands.
2. Altered spillway requirements.
3. Altered storage requirements.
4. New reservoir sites made feasible by new water supplies.
5. Alterations in replacement plans.
6. Changed firm and secondary power sources.
7. Additional drainage problems
8. Effect on seasonal water variations and on planned for water shortages.
9. Effect on total water supply.

III. Relief of seasonal drought on Southeast United States.
A. Increased rainfall on crop lands:
1. Changes in class of crops.
2. Increased yields of present crops.

B Stabilized stream flow and ground water:
1. Increased power production.
2. Improved water supplies and sanitation.

C. Altered drainage and water disposal requirements.
D. Adjustments in local industry and economy.

IV. Increased water supplies for Eastern cities.
A. Revision of storage operation schedules:
1. Municipal supplies.
2. Power.

B. Alteration of existing facilities
1. Dams, reservoirs, spillways, distribution systems

C. Reduced need for storage works
D. Effect on ground water
E. Effect on navigation

V. Miscellaneous effects
A. Increased snow removal; effect on transportation; costs, costs versus benefits
B. Increased runoff and floods
C. Erosion
1. Increased by increased runoff
2. Decreased by improved vegetation

D. Potential reduction of forest fires
E. Potential reduction or increase in hail damages

VI. Changed climate—local, national, global
(This study which may be more far-reaching than all others cannot be specifically outlined until considerable research work is advanced under "Procedure I–II").

Mr. ENGLE. Thank you very much, Mr. Bennett.

Now we have Mr. Michael W. Straus, Commissioner of the Bureau of Reclamation.

Mr. Straus, we are glad to have you here.

STATEMENT OF MICHAEL W. STRAUS, COMMISSIONER OF RECLAMATION, UNITED STATES DEPARTMENT OF THE INTERIOR

Mr. STRAUS. I am glad to be before this committee, Mr. Chairman, on the bills before you, H. R. 6 and 7.

Before making a formal statement I would like to present some material bearing on matters that were discussed yesterday, particularly as to the immediacy of this problem.

I got back Monday from some irrigation districts in the West. Every place that I talked to irrigation district trustees I was asked whether they should or should not invest their money in rain-making proposals that were before them.

One area—I don't see Dr. Miller here this morning—but one area was in Nebraska, on the North Platte project. All four of the districts there asked me as to advice as to whether they should make such an investment.

I told them that we were at the moment without a policy and without full appraisal of these devices which we would not challenge, and they went ahead and signed up the contracts for rain making.

I hope they win thereby.

As you see, that map over there [indicating] shows the extent that this practice is going on. I might add, that map is out of date. We would have to revise it every night to keep up with the rain-making contracts that are being signed in the West at the present time.

The statement of the gentleman that was just read here, the Under Secretary of the Interior, is from a man who as recently head of the Walt River water users project in Arizona himself has signed up one of these contracts.

Mr. ENGLE. How much money are they putting out for those kinds of things?

Mr. STRAUS. I have no total. I can name a hundred counties that have put out the money, but I haven't the total. They pay for it in all kinds of methods.

Mr. ENGLE. The map to the far right, with the pink areas, indicates the areas in which actual contracts have been made for artificial precipitation of rain; is that right?

Mr. STRAUS. That is right, sir; and the shaded areas grow on that map every night.

Mr. ENGLE. I will say this, that I know one part is correct. I see a little spot in California just across the border from Nevada. That is in the Bishop area, in my district, and rain-making experiments have been going on there for several years.

Mr. STRAUS. I see markings on that map that include Mr. D'Ewart's area, and Mr. Aspinall's area, and the areas in the districts of most of the members of this committee, some of whom are not present today.

Mr. ENGLE. The assumptions are that you are getting something out of it or these private agencies wouldn't be putting up cash money.

Mr. STRAUS. They certainly are getting something out of it.

Mr. ENGLE. I happen to know the fellow who flies for the people in the Bishop area. It is an electrical outfit in Los Angeles. I can't think of their name. It doesn't make any difference. At any rate, this fellow flies an old converted B–38 up there when they get the right

cloud formations. He has this dry ice that he sprinkles around in the plane with some kind of a hopper and when he gets in the right spot he turns it loose. One time out there they got busy and they sent out ground crews to check on how much snow they brought down and the ground crew got snowed in and they had to send rescue parties to get them out.

Mr. STRAUS. On the question that was just asked me, either on or off the record, how worth while is this, that is answerable and a very proper question.

One of the principal purposes to my mind of this legislation is to produce that answer. It requires an appraisal on an economic basis of these procedures for precipitation and conversion. I would like to mention briefly one other question that was discussed yesterday, the increase in water use.

I brought up this morning a report of the United States Geological Survey, Nation-wide, not West-wide, and having to do with ground water recovery, which of course comes originally from rain, that shows in the decade since 1935 pumping has increased from 10 billion to more than 20 billion gallons daily in the United States.

Of that pumping, one-half, or 10 billion gallons daily, is for irrigation purposes.

The next highest amount is industrial, excluding municipal supply, 5 billion gallons daily, municipal water, 3 billion gallons daily, and rural uses, excluding irrigation, 2 billion gallons daily.

The committee discussed yesterday the relative major uses of this water, which is also covered by the Geological Survey report.

The industries using the most water in the order of the amount of use, for oil refining, paper manufacturing, metal work, chemical manufacturing, office and buildings, including air conditioning and refrigeration, distilling, ice making and cold storage, food processing, rubber manufacturing, meat packing, brewing, railroads, and gas and electricity and dairying, in that order, and a number of other minor uses here and the survey concludes surprisingly enough the use for air conditioning, though widespread and increasing, is not nearly the greatest industrial use. They give as the greatest industrial use oil refining.

I would like to comment briefly on the philosophy of this bill in line with what members of the committee and witnesses said yesterday.

This bill is for water precipitation and conversion of a philisophy that is somewhat the same, largely the same as the bill for oil, for synthetic liquid fuels bill that I had the honor in the Seventy-eighth or Seventy-ninth Congress of presenting to this committee, and I note among the committee as they give serious consideration to this matter their feeling for precedent.

There is the precedent there. You had real actual, known physical facts, but not application, development and appraisal of them in the synthetic fuel field that would permit the benefit to be obtained from them and the Congress considered that bill and authorized the Interior Department, Bureau of Mines, to undertake such appraisal, acquire rights, conduct experiments, collect information and install both pilot and demonstration plants.

The history of synthetic oil since that time I think well substantiates the decision of this committee, which was reached after considerable work. In fact they held hearings across the country, on which I also

accompanied the committee, and the hopes in passing that legislation have been fulfilled.

The synthetic fuels processes are now avilable to the country and in several of the areas here the work has gone forward in Congressman Aspinall's district at Rifle, which I have been out to many times. They have developed a process there in Wyoming, at Laramie, in Pittsburg, Pa., and other plants, have made the contribution that the committee hoped would come from that legislation.

Mr. ASPINALL. Is the Commissioner able to say anything about the release that is being given out this morning about the new gas combustion?

Mr. STRAUS. No; I am not, Congressman Aspinall, because I am not familiar with it. What is it?

Mr. ASPINALL. The Secretary is releasing his story this morning of the awarding of a contract at Rifle, Colo., for the construction of a new third of a million-dollar plant which would use the new gas combustion process that has been developed there at Rifle, which may make the production of oil and its byproducts from shale economically feasible at this time.

Mr. STRAUS. That is interesting.

Mr. ASPINALL. There is a continual growth, to show what can be done with these programs.

Mr. STRAUS. In my opinion it is economically feasible and will be undertaken commercially any day.

Mr. ENGLE. What you are saying is that the production of oil from these materials is now in a position, due to this experimentation, to compete with oil dug out of the ground in its natural state?

Mr. STRAUS. I think on shale oil that is the case in my opinion and I think that there will be undertaken commercial operations.

Mr. ASPINALL. Largely due to the research work, not only in the breaking down of the shale itself, but in the mining procedures from the pilot plant.

Mr. ENGLE. What you are saying is that in addition they have developed the use of gasses in connection with this process which, as an additional economic factor, will make the process cheaper?

Mr. ASPINALL. The gas that is released, or a part of the gas or a form of gas that is released in the retort from shale itself, will fire the shale and take care of the production.

Mr. BOW. Mr. Chairman, does anybody have a record of how much has been spent on that program in the development, up to this point?

Mr. STRAUS. Yes. There is a complete and accurate record. I haven't got the figures with me. The original authorization, if I remember correctly, was up to $30 million and the initial appropriation within that authorization, if I remember correctly, was $5 million, and it is not a Bureau of Reclamation appropriation.

I have not got the figures with me, but they are a matter of record in the annual appropriations of the Congress.

Mr. BOW. That investment so far as the ultimate development is concerned might be a very small one.

Mr. ASPINALL. We passed the authorization bill in this committee last year to raise that authorization up to $60 million and that has not all been spent yet.

That is the over-all authorization for the work for coal and oil and gas.

Mr. Bow. So it is a good investment.

Mr. Straus, before you start your statement, could you tell me, has there been any consideration given as to the division of this $25 million that is asked for in this bill as between the taking of salt water and that of seeding the clouds?

Mr. STRAUS. I don't believe there has been an actual earmarking of any existing funds for that purpose.

Mr. Bow. The two are combined. I just wondered if you could break them down.

Mr. STRAUS. It wouldn't—in my opinion, that sum of money wouldn't be spent at all in the first year. This is an authorization. That would be submitted to the Congress in the annual appropriation were this authorization to pass.

Mr. Bow. My thought is I would like to have some idea if we can have it as to the amount or how you would divide that between the two projects since the two are in the same bill, with the single authorization; just how that might be divided between the two methods.

Mr. STRAUS. My own personal opinion——

Mr. BENNETT. I can give you a rough breakdown on that.

Mr. STRAUS. Mr. Bennett has a proposed rough breakdown. Would you like to give it, Mr. Bennett?

Mr. BENNETT. We have been thinking along these lines, Mr. Bow.

First, understand it is extremely difficult to give an over-all estimate of the cost of research. The ultimate cost will depend and develop as the work goes along. The $25 million figure, which is in the bill is an estimate and it is a rough estimate frankly.

We feel that on about the first year's program it should run in the neighborhood of $1 million, which would be divided about $700,000 into the salt water program and about $300,000 into the artificial precipitation program.

What that relationship would maintain throughout the life of the program is difficult to say.

We also have an additional breakdown, which is very rough, on the $25 million figure, which breaks it approximately $20 million into salt water program and $5 million into the artificial precipitation program.

Now as I said at the start, whether those figures held would depend upon what you discover as the research advances. I think that would help clarify your point.

Mr. Bow. Thank you.

Mr. STRAUS. Mr. Chairman, I would like to present a formal statement.

I appear before you with a view to the interests of the water and power users of the West. They and we are confronted with an actual and real and daily problem in matters of conversion, precipitation and their control. That problem can only be solved by the Congress and Reclamation commends this legislation to you for action and recommends such action.

The United States Government has made an investment of approximately $2 billion in the development of water and power in this country through the United States Bureau of Reclamation, which has thus become the Nation's principal water conservator and handler. Others have spent larger sums. All reclamation basically starts with finding sweet water somewhere, conserving it, getting kilowatts from it,

transporting it, and delivering it to where it is needed. Therefore, Reclamation has a vital interest in these bills concerning artificial precipitation, salt water conversion, and the development and control now before you. Reclamation looks to the Congress for guidance in welding these arts into an established responsibility.

Reclamation did not go and ferret out this problem and submit it to you. Progress and development created the problem and we have been confronted with it. In fact, we laid it before the Eighty-first Congress and now request the Eighty-second Congress to chart out the ground rules and national policy by which we may proceed in the public interest to bring these new developments to the full service of the country.

As the world's greatest accumulator and distributor of water and generator and transmitter of kilowatts wrested from that water, as well as builder and custodian of the Nation's reclamation investment, Reclamation has, naturally, been alert to and kept a close watch on artificial rainfall developments as they progressed for a number of years.

This was made possible by the courtesy and cooperation of the Army-Navy-General Electric groups engaged in "Project Cirrus," and the cooperation of the United States Weather Bureau, plus several universities and private concerns.

Reclamation considers that artificial precipitation represents a tremendous scientific development to be recognized by any agency devoted to water conservation and use. We view conversion of sea water as a very possible source of additional sweet water. We recognize new potential national assets and we are perhaps more cognizant than those not experienced or responsible for handling great water supplies with the inherent conflicts and dangers in entering such fields in the absence of establishment by Congress of national policy for those fields by such measures as are before you.

The new and as yet not fully developed arts of precipitation and conversion must be, Reclamation believes, encouraged, appraised, assisted, and controlled to serve our citizens. That you will do as a result of your considerations. Water in rivers, as well as salt water in the ocean and moisture in the clouds, is a notorious insurrecto. It disregards completely local boundaries, district, county, or State lines. Water willfully runs downhill or falls where it pleases. In clouds, it frequently rises instead of falling. I know no other organization than the Federal Government that is capable of tackling a problem of the breadth and scope that is now before you. The full resources of the Government are required to encourage and develop these arts, keep the books on the variety of practices now going on so that some firm economics may be established in appraising them, fashion some needed measuring rods, and then provide the ground rules of control.

So that the committee may have some information as to the extent of current or very recent rainfall modification operations Reclamation has prepared the map before you from such voluntary reports and data as are available.

We can identify by name 100 counties which are targets for commercial rain making. Replies of surveys disclose a variety of schemes for rain making, embracing a number of methods for payment, and existence of an assortment of sponsoring associations, groups and interests.

Many are irrigation districts with which Reclamation works. Charges for rain making surveys range from 1½ to 12 cents per acre, when an acreage basis of charge is employed. Other contracts are on a flat rate while still others are based on the amount of water entering reservoirs whether it comes from actual or artificial rain or snow.

Great metropolises, cities, towns, irrigation districts, associations of farmers, and all manner of organizations are dabbling in the business. One commercial firm alone is reported to have rain making contracts with a target of nearly 200 million acres.

This survey is definitely incomplete. I am convinced it is an understatement of existing practices. I do not know that there exists anywhere a competent and complete statistical inventory of current rain making operations. That is one most-valuable result which this legislation might yield. Nevertheless, the summary inventory Reclamation has made in its own studies of this problem as summarized on the map is informative and positively indicative of vast and growing scope.

One of the benefits that could come from this committee's endeavors would be requirement of the responsibility for securing and reporting on the many artificial precipitation operations that are going forward.

It is only when such reporting is undertaken that prerequisite ground work and information is provided that will eventually permit establishment of respectable measurements by which the economic feasibility of various rain making endeavors may be appraised. To a Bureau of Reclamation that must constantly consider not only the physical possibilities, but also the economic feasibilities of water development and establish such feasibility, this is a primary essential.

Reclamation accepts the principles of rain making as an accomplished fact, although recognizing that techniques differ, that improvements are not only possible but probable and that some claims may be overly enthusiastic. Reclamation would like to place this new development in context for you in the Government water development and conservation programs.

In so doing, I wish to remind the committee that the fight for good sweet water is getting fiercer, not only everywhere in the arid West, but throughout the rest of the country, including the East, as well as throughout the world.

That is only natural as our drafts upon our good water supplies increase and as the availability of water proves itself each day the controlling point of agricultural and industrial development.

Each year we are using more water per capita. Water shortages are reported from areas once considered humid. Water use, in fact, may be accepted both as a measurement of domestic, industrial, and agricultural development, and even as a measurement of standard of living and civilization itself.

Agencies of the Federal Government, as well as local governments and private enterprise, have invested multiple billions in water development, not only in obtaining water, but also in flood-control works, industrial plants—including many of strategic value, municipal water works and drainage facilities for protection of agriculture, transportation, railroads, highways, and a host of other capital investments.

All of these works, both existing and future, are at present designed on the basis of existing water supplies resulting from natural precipita-

tion. The safety of towns and cities, the protection of transportation systems from floods, the power for industrial plants, and irrigation systems are all based on natural precipitation. Now there has been added an unknown of unnatural precipitation.

If the total precipitation in an area can be increased, as now seems an acceptable thesis under favorable conditions, many future designs of works for water utilization would have to be adjusted and some of the existing works might require modification at considerable expense.

That would be true across the board, including the greatest waterworks of man, designed and built by the Bureau of Reclamation. Spillways may be larger, dams higher, canals and laterals wider and deeper. More land may be irrigated. More power may be generated. Of possible greater significance, fewer droughts may be experienced and the control by man of a significant portion of the rainfall may even so stabilize the water supplies in some areas as to reduce the need for costly irrigation works, and at the same time make available more water for needed power generation. Indeed, Reclamation's interest in this program and legislation is great.

I have been asked the question whether artificial precipitation might not put the Bureau of Reclamation out of business. I don't think that should be the criteria of your consideration. But, for information's sake, it is my belief that artificial precipitation and salt-water conversion certainly would not put the Bureau of Reclamation out of business. It probably would increase our business although we strain to accomplish what we have today.

Even the greatest optimistic artificial precipitation enthusiasts with whom I have talked have not yet advanced the thesis that that artificial precipitation can or will assume the accuracy of precision pickle barrel bombing so that rain drops can be released by aim on crops to be irrigated.

Reclamation's primary irrigation business is collecting water wherever it may be and moving it to exact spots where it is needed—whether it comes from rainstorms, melting snows or glaciers, rivers or lakes, or even underground supplies.

I consider artificial precipitation in terms of another needed and welcome source of water supply—and a very valuable one—which supply as released should be collected and saved from where it might fall to the place where it might be needed.

This additional water would still have to be impounded and distributed to lands where it is needed by what you have come to consider the normal reclamation works. The runoff from the steep and rocky areas must be placed in the fertile valleys and passed through power plants even as is done today, but in greater volume with a new source of water supply.

Flood-control works of today would have to accommodate the new quantities and much additional fertile land might be brought into production.

The benefits which would accrue would be tremendous, and I am frankly disturbed at the realization that to date we have not yet developed a reliable yardstick by which we can at least estimate this increase in available water supplies that may be given to us.

Thus, the conservation and distribution of additional water that might be supplied by precipitation will impose upon all who deal with multiple-purpose river-basin developments new tasks.

With the water which may be made available as a result of salt-water conversion, I am more optimistic because we shall at least be able to control its quantity and lay our plans accordingly. While this facet of the legislation before you will be productive, I feel sure, of considerable new fresh water near our seacoasts, and a quantity of sweetened water in our island areas, all of which will require adjustment of our plans for water use, I do not believe that this problem will be as difficult of solution as those arising from modified hydrology of our Nation.

Nevertheless in both branches of this endeavor to increase our total fresh-water supplies, we are met with a challenge to plan our water-works in such a way that they can accommodate the new quantities for the greatest benefit to the most people and at a minimum of cost. That affects every proposal for authorization of an irrigation project that will come before this committee.

That salt-water conversion is physically possible nobody challenges. Only grandma's teakettle on the stove is required to prove this point. The problem is high volume and low cost of conversion of limitless sea water.

Several very promising methods for economically converting salt water have been investigated in one degree or another and it appears that there may be some possibility that new methods not yet developed to maturity may prove of value in moving over the economic line.

Compression distillation has been developed, I believe, near to its limit in plants of small size. By this I mean the largest plants developed by the Army and Navy for use aboard ship and on shore installations are small in size as compared with the needs of municipalities and irrigation interests.

For example, the largest compression distillation units under development in private industry on which we have been able to obtain knowledge would have capacities in the neighborhood of 20,000 gallons of fresh water per hour. While a battery of these units could be installed no doubt so as to produce possibly several million gallons of fresh water a day, even this amount is no greater than a large spring and would not supply a city like Los Angeles or New York or irrigation water in any appreciable amount. I visualize the construction, possibly, of a much larger compression distillation plant or modification thereof which in itself might attain much higher efficiencies than the smaller plants.

We are informed by research organizations of repute that there is great promise in the field of chemical methods for removing salt from water, and I believe that considerable basic research in this field is desirable to ascertain whether it may be useful for this purpose.

We are already aware that atomic energy reactor plants use large quantities of water for cooling purposes. This heat is wasted, and I am happy to learn that the Atomic Energy Commission is already investigating the feasibility of utilizing this waste heat for many purposes. But I am not informed that accurate economics on atomic energy are now publicly available, at least they are not available to me.

We should not overlook the possibility that it may be possible to derive commercially valuable chemicals from sea water while extracting pure water at the same time. If this can be done on an economical basis, the revenue from the materials extracted might be used to

reduce the cost of the fresh water (an item of major interest to irrigators).

On the other hand, the chemical industry itself might find through this research that by producing fresh water as a byproduct of its primary purpose of extracting chemicals from the sea the sale of the water could reduce the cost of the chemicals to the extent that production of fresh water might be attractive to private industry.

It should be borne in mind in this regard that this research is not directed toward the production of fresh water—or chemicals—on a large scale but toward research and demonstration of means by which others—including private industry—could, if necessary, produce such water themselves.

Very real and practical considerations have confronted the Bureau of Reclamation in connection with artificial precipitation. We have received urgent requests from operating offices, one in El Paso and one in Boise, Idaho, and I cited one earlier from Nebraska, for advice as to whether they should encourage or discourage the water users association in contracting for commercial rain-making services.

We are, frankly, at a loss for an answer to these good people. Perhaps this legislation will provide the answers eventually.

Today we dare not encourage them to spend their money on these activities, and we are not at liberty to discourage them from doing so. If additional water could be made available to them, we would be the first to want it, but we are fully aware that the average irrigation farmer has his normal expenses and cannot afford to be pouring money into a venture which he is not sure will repay him.

Numerous water users associations throughout the West have already contracted for such services and we view their investments to be of questionable value to say the least. Nevertheless, I am not opposed to these operations and in fact believe that until it is shown by scientific research that such operations are causing any effect whatsoever and particularly any damage, we assume that they are—or should be—at least contributing something to the general knowledge of the subject.

This contribution would be greatly enhanced, however, if these commercial cloud seeding organizations could be required by Federal statute to report their operations and install scientific measuring apparatus sufficient that analyses and evaluations of the results could be made by impartial organizations.

I wish to recommend all features of these bills to this committee which have to do with encouragement and measurement and appraisal of artificial precipitation and salt-water conversion.

In this connection, I believe the Bureau of Reclamation and the other water conservation and development agencies of the Department of the Interior are particularly qualified to carry out these programs.

The approximately 50 years' experience of the Bureau of Reclamation has made our engineers as well as our lawyers keenly aware of the differences as well as the similarities between the problems of technology and water rights in salt-water conversion and artificial precipitation, on the one hand, and the problems of hydrology and rights to surface and underground waters, on the other.

In closing my remarks, I believe that we should all recognize, first, that in the salt-water-purification program and that of the artificial

rainfall, we have a potential national asset which should be investigated rapidly and exhaustively; second, that the job is one for the Federal Government; and, third, that private and commercial organizations have a real place in both programs and should be cnouraged, not discouraged.

Mr. ENGLE. Mr. Straus, are you finished?

Mr. STRAUS. Yes, sir.

Mr. ENGLE. I am in agreement with your conclusion with respect to the responsibility of the Federal Government and private industry in this program, but I am not so clear about how the division should be made.

My initial feeling about the thing is that so far as basic research is concerned, that it would be wiser to leave that on a contractual basis, in some form or other, with those universities and private agencies which have already made very large strides in the direction of development in both of these fields.

I have a feeling that it would be very difficult for the Government to set up a research staff. It would take several years, and in all probability the men who have had the experience and background in these fields would be unavailable on a permanent basis except after a long period, perhaps, of trying to get an organization together.

I am interested in that respect in the statement made by Mr. Bennett and especially on page 3 of his statement where he says that the estimated allocations for the first phase of this work would be 65 percent among the Federal agencies and 35 percent among the various private industries.

Now, just assuming for the sake of discussion that when we get to the pilot-plant phase of these operations, especially in the field of sea-water distillation or conversion, that that would largely be a Federal concern because the pilot-plant operations would involve the selection of the best processes and the pilot-plant testing of the best processes, which logically could be best handled by a Federal agency with respect to research

Don't you think whatever research that has to be made could be made more beneficially by contracting with private firms with a broad background already in the field and with technicians in universities and with universities themselves, such as Cal Tech, and Southern California, and MIT, and others? Do you desire to comment on that?

Mr. STRAUS. Yes, sir, I would.

I think that to the full extent that private or public institutions, corporations, or universities, or not for profit institutions, that are not governmental in character should be employed and that any funds which should become available under any authorization that is before you that can be used to further their work should be so used.

That has been the program in the synthetic fuels bill, to which we have referred. We should be as a matter of normal economical administration able to avoid any duplication of that work that we can get done by these institutions, either without or with use of these funds. We should avoid that duplication.

There are certain things that they state themselves most frankly interfere with that activity and that research work by these institutions. One, there are no institutions that are equipped or available

to collect information from all over the country as your Federal Government is.

Another item that interferes with their ability to undertake all this work is that there is legal responsibility incurred in these experiments.

There have been lawsuits filed against artificial precipitators for not causing or for causing too much rain or snow.

I talked with the leaders in artificial precipitation from the General Electric Co., which, without recompense has already invested considerable funds in such experiment, and they are curtailed and frankly alarmed by the fact that if they continue to run around and seed clouds, they are the target of damage suits by both private and governmental bodies and the scientists that are conducting this work are discouraged by the administrators of their corporations from becoming such targets of damage suits.

There is a clause in this bill that the Government assumes liability in such events.

Mr. ENGLE. Section 5 of the bill takes care of that, but as I read these various steps, the first one amounts to a question of evaluating the research which has been done to date and the second would be setting up a group of consultants and the function of these consultants would be to advise with you and make recommendations; third, the planning staff, consisting of a project director and his assistants who would direct and coordinate all phases of investigations, maintain liaison with cooperatively participating agencies, give technical guidance to all operating units, and so forth, and fourth would be preliminary laboratory investigations, to be conducted on known processes of salt water reclamation which have a possibility of economical feasibility and to explore new methods and possibilities, and in the fifth step you get down to the possible pilot plant operations.

I wouldn't have any objection to any of those others except that I think on your fourth step where you in effect expand and go forward from the known boundaries of present research, that you are going to have difficulty.

What I am afraid of is that there is a tendency in Government, and it is not limited to the Bureau of Reclamation or any other—and I don't intend to imply that—but there is a tendency in Government to build up a rather huge agency to carry on these things and more often than not forward progress is lost because of the bulk of the organization and with respect to this fourth step in particular it seems to me that could be more properly handled by those agencies which have brought research to its present level because it is an extension of research. In order to carry that on, if the Government is going to do it, you are going to have to go back and pick up some of the scientists and engineers and technical men who have carried on the research to its present level or else you are going to have to train a new group of them.

Mr. STRAUS. Or else we are going to have to ask them and enable them to continue and go forward with their research in their present field of operation and their present situation, whether it be a university or a corporation, both of which are in the business.

Mr. ENGLE. That is the alternative I suggest, and what I want to know is how you can write that legislatively, if that is agreed it is the way it should be done, so that it will in fact be done that way?

Mr. STRAUS. This provides in the bill, page 3——

Mr. ENGLE. That is the authorization.

Mr. STRAUS. It provides the authorization. It does not attempt to stipulate on which particular detailed process this provision of section 2, clause (e) shall be exercised. If we are looking for a criteria of that, or if I may express my own philosophy on it, in the case we might look to the precedent of this committee itself, set in the synthetic liquid fuels program, and which I helped administer, where the universities, four or five of them, a number of corporations, which I could name several, such as the Coppers Corp. and Johns-Mansville, and various corporations, were contracted with to develop described devices, and also you cited the committees from industry. It was immediately apparent after the Congress passed that synthetic liquid fuels bill that we required both technical and technical industrial advice, and to that end that was secured by setting up advisers to the Secretary, who was the vehicle of authority in that bill, as he is in this bill, from both the coal and natural petroleum industries, both of whom aided and supported him, and also supported the legislation.

Mr. ENGLE. Well, conceding all that, and just as a preliminary matter, it would seem to me that when you start expanding the base of your research you have to rely on those people who have knowledge. You have to either get them in your organization or set up a new one. It would be much easier to do it the other way.

That raises the question about why 65 percent of the initial fund should go to the Federal agencies and 35 to private installations, when the major part of the work, except for these planning and consulting groups in the initial phases, would be in expansion and research.

Maybe Mr. Bennett would like to comment on that.

Mr. BENNETT. To a certain extent, Mr. Engle, that division is arbitrary. We attempted to set forth that which we felt would be a good initial phase. Of the $700,000 we figured that about $240,000, which is roughly the 35 percent, would go directly to the private and semicommercial type of firms, to carry on work perhaps they have already started, or even to farm out, if I may use that phrase, to even new fields.

Mr. ENGLE. Why do you need an overhead of 65 percent?

Mr. BENNETT. Let me finish, and I will pick up the rest of it.

On the other side of the ledger, which we grouped as Federal agencies, we included the consulting staff, which would consist basically of people from these firms already engaged in certain aspects of this work, so there you have another factor which is really a part of your commercial type of work.

Mr. ENGLE. Do you refer now to this consulting agency going into the field of actual extension of research?

Mr. BENNETT. No; the consultants would be in terms of advisory as to what types of research is to be carried on.

Mr. ENGLE. Sixty-five percent of the money is in what you might call administrative overhead and consulting agencies, with only 35 percent in the actual extension of research and that is the only part visualized in the program up to that point.

Mr. BENNETT. Let me give you this breakdown. I think it will clear that picture.

We figured the consultants, probably about $40,000. We figured on the planning staff, about $72,000. In laboratory and other pre-

liminary investigations, which would be confined principally to new methods on which there is not now available any, or at least very little knowhow, $310,000.

Now there is the bulk.

Mr. ENGLE. What is that last?

Mr. BENNETT. $310,000.

Mr. ENGLE. What is that for?

Mr. BENNETT. That is laboratory and preliminary investigations, generally covering methods not now under way.

Mr. ENGLE. That is the point where I think you ought to put that $310,000, into the private agencies and the colleges and universities which have already done the work.

Mr. BENNETT. Well, in terms of cost, I don't think it makes a great deal of difference, when you begin to get into the field which is relatively untouched at the present time.

Mr. ENGLE. That is just the point I am trying to make. If you get into the field that is relatively untouched, you work from known premises and the people who know those premises are the people who have been doing it. Therefore, in order to carry that on in a separate Government agency you either have to get those people or train them and I say it is easier to start right where you are and say, "Here, you people have been at this for quite a while and you have a basic fund of information and you have reached a certain level already. What we are saying is we are willing to make a contract with you to go ahead with this, and to expand the field of your knowledge, rather than try to set up a separate organization."

Here is what I am afraid of. If we aren't careful the Appropriations Committee and people in the House and Congress are going to say "Here you are setting up a new Government agency to do something that private industry and the universities have already started on and have progressed fairly well. We don't think you ought to set up a Government agency to do that. The real function of the Federal Government is to correlate existing knowledge, and to put pilot-plant-testing knowledge to what is already gained."

Mr. STRAUS. I don't think I disagree with you in any way, Mr. Chairman. What the Government will have to do will be to get the services of the qualified men in this field.

Mr. ENGLE. You can't get them. They won't leave the universities and they won't leave private industry.

Mr. STRAUS. I am sure people will say what you say they will say. You are absolutely correct. The universities and the corporations do ask themselves for this legislation. I don't feel that they feel that they are able; I know I am not able, maybe the committee is, to put this in definite legalistic categories of division of moneys.

It comes to my mind immediately the two leaders in this field that I have talked with from the General Electric Co. They certainly have to be kept at their work. They are research scientists. I think they will determine in what field they will work, whether they do the same work with that corporation or they will do it elsewhere.

They are the ones that are going to determine it. I suspect they will do it with the corporation because I have noticed scientists don't like to work for the Government under present regulations, and that would be possible to meet their desires in this case.

Mr. ENGLE. It is perfectly possible under this legislation to do it, but we have to write it in such a way that at least the general principles of how the thing is going to be carried out will be defined in the legislation.

Mr. STRAUS. You could add policy clauses that covered it.

Mr. ENGLE. I just think it is a better and more practical way to do it and in the beginning it answers the critics of this program who will unquestionably raise the question as to why the Government should start out all over again or go beyond the present borders of knowledge, and in doing so, have to call the men who have the knowledge.

Mr. BENNETT. One point I wanted to make sure is clear, Mr. Chairman, that that $310,000 which I mentioned would be distributed among several Federal agencies who already have experts in many of these fields.

Mr. ENGLE. I know that the Navy has done a good deal of work in this field.

Mr. BENNETT. The Navy has and the Army has.

Mr. STRAUS. The Air Corps.

Mr. BENNETT. The Bureau of Standards has done quite a bit of work on it and several others.

Mr. ENGLE. But I don't like to see the Federal Government stepping in and taking over a field where a great deal of progress has already been made and where in order to do so they will either have to get the men who made present progress or educate the men to the level of those who did make progress.

Mr. STRAUS. I hope you adduce the desires of the men who are outside of Government on that point when they come before you. They have various opinions on where it ought to be, but they want this type of Federal legislation. They say that this cannot be done so great in scope by any agency other than the Federal Government, but certainly they should be used—they are the only talent that exists.

There is a lot of governmental and a lot of private talent but I can't phone over to the Civil Service Commission and ask for a C–12 rain maker on Thursday and get one.

Mr. ENGLE. That is exactly the case. You can't possibly do it, but there might be an effort and I don't want to see that done. I think it would be the wrong approach to it and it would lend this legislation vulnerable to an argument, which we can very easily get around if we define the case properly. I didn't intend to take all this time. Mr. Crawford, do you have any questions?

Mr. CRAWFORD. I don't believe I have any questions, Mr. Chairman. I think the statements are sufficient to give us plenty of thought about this subject at the moment.

Mr. ENGLE. Mr. Aspinall?

Mr. ASPINALL. No questions.

Mr. ENGLE. Mr. Poulson?

Mr. POULSON. Well, I consider that I concur with you, that the purpose and the ideas require that we should establish some policies to keep them from just trying to set up competitive groups rather than accomplishing the end result.

Mr. ENGLE. We used to have a doctor in Redding, Calif., called Dr. Doesiesh. He put out a little paper called the Shasta Digest, which was full of caustic comment about the administration that

has been in power for the last 16 years. Some of his stuff was pretty good, notwithstanding that I didn't agree with it all.

One statement he made was, he said, "Bureaucracy, like the mad Mrs. Winchester's house, everything growing."

Now we have to write our legislation in such a way as to meet that kind of criticism, and I am perfectly sure, as I said before, that we will get that if we try to put the Government into a field already fairly well occupied from the standpoint of research by technical men in universities and private industry.

Mr. STRAUS. And in government.

Mr. ASPINALL. Will the gentleman from California yield?

Mr. POULSON. Yes.

Mr. ASPINALL. Mr. Engle, should this program be treated with any different approach than that which we take toward, we will say, the Institute of Public Health, out in Bethesda, Md.?

In other words, we give them a certain latitude of operation. Should we be any more particular with this program than we are with them?

Mr. ENGLE. I am not familiar with that particular one, but I think we can't draw the lines too strictly. If you do you are liable to harness the thing up so that the job can't be done.

Mr. ASPINALL. As far as competition with private industry?

Mr. ENGLE. I am not referring to competition with private industry. I am referring to a time-wasting and personnel-wasting performance which has to draw on these sources of technical knowledge which already exists and endeavor to get them into a separate organization in Government.

Now I think the general principles ought to be laid down in the legislation and beyond that, it is an administrative matter.

We can't just write a section in this bill and say you are going to hire everybody or you are going to do all your research work through contract, but we can lay down some general principles and that is the thing I had in mind, not in definitive legislation that would strait-jacket this program.

Mr. POULSON. I think along the same line, Mr. Aspinall. I can remember Mr. Lilienthal telling a group that he had found out that our Government regulations are such that they can't encourage the people to accomplish the great things in this field that are available and which man can do, and that while the Government should be the top correlating agency and should probably have the top control to keep it from getting into the hands of any other group, nevertheless, because of the way man is made he has got to have some type of incentive and reward and governmental operation doesn't work that way; so he has found it advantageous to work with universities and with private companies in getting them to develop and correlate the ideas.

That principle is what I believe in.

Mr. ASPINALL. I will go along with you just so long as you don't harness the legislation so that you get into a strait-jacket.

On the other hand, I think Mr. Engle is correct when he says certain general principles must be laid down.

Mr. POULSON. That is right. That frankly is really up to the administrative head as to the approach, but when they want to accomplish it that is probably the way they will have to accomplish it.

Mr. STRAUS. I would like this committee, recognizing the problem you are confronted with, to get some testimony on that point from various witnesses that I understand will come before you from private industry, corporations, not-for-profit corporations, educational institutions.

I want to say that to the best of my knowledge they are uniformly desirous and also tell this committee that they want the Government to take some leadership in this field. That does not bar their appointment. For example, there was a statement introduced and the committee has not had a chance to read it yet; it was introduced yesterday from Fairfield Osborn, of the Conservation Foundation, an educational and research institution. I think he is the head of the New York Museum, if I remember correctly, in which he says—

> We are glad to note that the Congress is again considering authority to enable the Department of Interior to undertake substantial studies in this field. It is clearly in the public interest that this whole question be explored from as many different points of view as possible in order to determine beyond a reasonable doubt whether it would be advantageous to encourage conversion of sea water on a large scale.

You will get the same view from the General Electric Corp., which has spent considerable of its own funds and now desires legal protection through such a bill as this, and from others of the groups that you are quite properly seeking to protect.

Mr. ENGLE. I haven't been too impressed with Government research. Just to give you an illustration, which is currently in our mind in regard to manganese, we spent something like $20 million out in Montana and just threw it away during the war, trying to develop a process and they still did not have one out there in Montana.

Then spent between $8 and $10 million at the Three Kids, in the State of Nevada, and they did not produce a bucketful of manganese.

Now Southwest Engineering in Los Angeles has come along in the past few years, under a contract with a private operator and has devised a process for the beneficiation of manganese and it is the one currently being put into operation at the Three Kids manganese operation in Nevada, and they know that it is going to go.

That is just an illustration and we do have groups like that who do this kind of research and do a very competent job.

It is hard to reach out, as you know, Mr. Commissioner, and say "We want a CAF–15 rainmaker tomorrow afternoon or 15 months from now" but there is some fellow down at Cal-Tech, who has been mulling this problem around perhaps for 5 or 6 years, who has a vast amount of technical information on it and the same thing is true of certain private companies who have spent their own money and would be glad to spend more, specially if the Government would put up some money to put their men to work.

Mr. POULSON. Just one more question, Mr. Straus, to try to explain my point. It is because of some of our limitations on governmental operations, which I think are justified, that you can't go out and get one of the best scientists and pay him, for example, $20,000 a year. You are limited in that, but you can make a contract with some organization which has a man like that on the payroll, to accomplish something, isn't that right?

Mr. STRAUS. And I am limited in that too.

Mr. POULSON. I know you can.

Mr. STRAUS. Yes, sir. That is correct.

Mr. POULSON. Now in the same way, what I was driving at, is that you should not go out and hire men under your limitations, nine- and ten-thousand-dollar men, to try to accomplish what this top $20,000-man is doing.

In other words, he can't do it so you are limited. That is why I think that you shouldn't depend entirely on doing all of this work within your own organization because you are limited and you can't compete with others in getting that type of man.

Now you have good men in your organization. I am not discounting Dr. Bennett or any of the others but you are limited, aren't you?

Mr. STRAUS. You are certainly correct, Mr. Poulson. I can't go out and hire a man for $20,000 unless I wanted a 4-year congressional investigation for doing it, but I also want to say that we are in agreement with your philosophy that these skilled technicians, these scientists, must be used, because they are limited in number, wherever we get them and use them best, and that is in most instances in their opinion—and I think that is what controls—as well as our opinion, in their present field of operation and situation, and that is the reason why provision for that is made in this bill.

That is the intent and that is the philosophy and that is the way it would be practiced. If the committee has means of defining that more closely I certainly suggest they go forward.

Mr. POULSON. I agree with you. I think I also agree with you that there must be an over-all agency which correlates all these efforts in behalf of the public interest.

Of course, that would have to be the Federal Government.

Mr. STRAUS. Rain is the public matter in the end result.

Mr. ENGLE. Mr. Saylor.

Mr. SAYLOR. Yes, sir.

Mr. Straus, do you think both of these subjects of the conversion of potable water, and artificial rain making, should be involved in one bill?

Mr. STRAUS. Yes, sir. To my way of thinking they are both sources of badly needed new water supply, with different mechanics for getting them, both of which are practiced extensively now in this country.

Mr. SAYLOR. In other words, therefore, you feel that that provision of the bill in your opinion should be continued?

Mr. STRAUS. Yes, sir. I do. From the point of view of Reclamation, we want to get some new water supply.

Mr. SAYLOR. All right. Now then, yesterday we had Mr. Warne up here and he, together with Mr. Bennett, testified with regard to the various methods and he gave us some idea of the cost of these individual methods.

Now since the Bureau is interested in these bills, you must have a goal toward which you are aiming as far as cost is concerned and I think the committee should have the benefit of your thinking along that line.

What do you figure is the goal for the production of potable water from salt water as far as cost is concerned?

Mr. STRAUS. The only goal that we can have is the lowest cost water we can get at any particular point where it is needed. You get in, Mr. Saylor, a fascinating subject of what water is worth. I know

water that is worth up to half a million dollars a quart in some places and we would like—and particularly from the point of view of agriculture—the lowest cost water we can possibly get. In Mr. Poulson's country they pay anywhere from $1 or $2 up to over a hundred dollars an-acre foot. Those who got it earlier are the luckiest ones.

Mr. POULSON. What is the highest price paid today by any water users for water for irrigation purposes that you know?

Mr. STRAUS. The highest price paid to the Bureau of Reclamation for any water for either agricultural or municipal uses is in the area of Santa Barbara, Calif., where under a contract with the Bureau of Reclamation, they pay $35 an acre-foot for municipal or industrial water and $25 an acre-foot for agricultural water, under a county water authority under which lie four or five different irrigation districts and a number of municipalities.

That is the highest price paid to the United States Government, which I am familiar with. That is far less than costs of water, principally in the far Southwest, the area of the greatest deficiency, which run well up above a hundred dollars in many instances per acre-foot, and if you wanted to go into some other examples, and some of you members of the committee have seen the salt water conversion plant on Wake Island, which is far more expensive than that, and if you get down to these water bags on aircraft, rafts, that fall in the Pacific, you are getting into the multiple thousands per quart for water.

Mr. SAYLOR. In other words, $25 an acre-foot is the highest price that is paid for agricultural water to the Bureau of Reclamation?

Mr. STRAUS. To the Bureau of Reclamation or to the United States Government to my knowledge.

Mr. SAYLOR. Now you said that there are some other areas that pay for agricultural water as high as $100 an acre-foot.

What areas are those?

Mr. STRAUS. I could identify them. They are generally in the far Southwest and in Southern California, and it is generally for limited amounts of water during times of great shortage, in such areas that you have freedom of choice as to whether you pay $300 fine or go to jail for 30 days if you sprinkle your garden or wash your automobile.

Mr. SAYLOR. What particular areas there do you know of that they have paid a hundred dollars an acre-foot for water?

Mr. STRAUS. I think I can produce the names of some communities that are either just north or just south of the Tehachepe Mountains in California. I think I can produce some in Arizona, too.

Mr. SAYLOR. Will you, for the record, put the names of those areas in?

Mr. STRAUS. I will be glad to.

(The information is as follows:)

Following is a short list of communities and their prices paid for water. The water uses include domestic, municipal, industrial and some agricultural use:

	Price paid per acre-foot
Fallbrook Public Utility District, Calif	$120.46
Monrovia, Calif	83.00
Lake Side, Calif	121.00
Grand Forks, N. Dak	163.00
Tyler, Tex	163.00
Austin, Tex	131.00

Mr. SAYLOR. Now how many areas that are presently under the jurisdiction of the Bureau of Reclamation could they stand $25 for an acre-foot of water?

Mr. STRAUS. Well, under present concepts and standards rather few, but we operate in 17 Western States only as you know.

In my own opinion water is worth what you have to pay for it when you need it. That is the only end conclusion I can come to.

Mr. SAYLOR. I realize that but we deal, or should be dealing with practicalities and not too much with theory in this matter, and if we are going to ask the Government and the taxpayers to put up $25,000,000, I am not just going to vote for it because it is going to give the Bureau of Reclamation something to play with.

If they can produce water at $25 an acre and you have areas that can buy water at $25 an acre, then it becomes economically feasible, but if it costs $25, or $100 an acre to produce and the people cannot buy it, then we are talking about an actuality that just is impossible to achieve.

That is why I am trying to find out from you where the areas are that in your opinion can stand $25 an acre other than the ones that are now making it?

Mr. STRAUS. I want to confine myself to facts and actual experience of the Bureau of Reclamation.

We are now producing and are selling water for agricultural purposes for $25 an acre-foot and for $35 for municipal and industrial use and that is in the opinion of the people that are purchasing it, a bargain.

That is as far as the actual fact goes now.

I do know that people pay lots more for water, but I must restrict myself to our own existing present practice and not get it the area of forecast, and I certainly am not going to forecast the eventual price of converted sea water, or rain water.

Mr. SAYLOR. No; but we should have some idea of the goal. In other words, you have stated that you want to get it as low as possible, is that correct?

Mr. STRAUS. Yes, sir. That is the object and philosophy of this bill.

Mr. SAYLOR. That is your ultimate aim, and it makes prices that are now being paid are those that you testified to.

Now, are there any areas that are not paying $25 an acre that in your opinion could pay $25 an acre for additional water?

Mr. STRAUS. Oh, yes; there are many that are not paying it. Generally, a lot of people get water for $1 or a little more, an acre-foot. They are the fortunate, farsighted ones that secured the easily available water, legally and properly, when it was available at those prices. They are not the ones who are getting new water now.

Mr. SAYLOR. But are there any of those areas which could now pay, would pay now, or could or would pay $25 an acre for additional water?

Mr. STRAUS. Yes. Santa Barbara is one. They got earlier water through their earlier limited requirements at far less than that but they couldn't get additional water any other place at anywhere near that cost.

Mr. SAYLOR. Is that for industrial and municipal use?

Mr. STRAUS. Both, and also agricultural use.

Mr. SAYLOR. Now, the second question that I have to ask you is with regard to artificial rain making.

You have stated that one of the difficulties with the present set-up is the inability of those who are involved in artificial rain making to control, or to give the assurance, that there would, or would not be rain.

What special ability does the Bureau of Reclamation have that it will be better able to control the elements than present people that are doing it?

Mr. STRAUS. None whatever, until the art is developed, but to try to be responsive to your question, there are at least two forms of artificial precipitation that are in more or less common practice at the present time.

One is dry icing certain types of cloud formations. That has a limited effect in that the dry ice dissipates rapidly and does not spread over a thousand-mile area.

Mr. SAYLOR. Let's take the first method you referred to. That is really a local method, is it not?

Mr. STRAUS. In that it dissipates before it can get too far, while the alternative method which is also used of silver iodide may drift in the clouds over several States and thousands of miles.

Mr. SAYLOR. Therefore, whether you, the Bureau of Reclamation, does it, or private industry does it, or private individuals do it, the drift will be the same if you use the second method; is that correct?

Mr. STRAUS. Yes; if Congress permits it.

Mr. SAYLOR. Well at present private industry or private individuals are doing it; is that not correct?

Mr. STRAUS. They are both doing it. I have heard of private individuals in the experimental field say that there should be a legal barrier on them in doing it. I am citing testimony of a General Electric scientist before Congress.

Mr. SAYLOR. You say that before a congressional hearing?

Mr. STRAUS. Yes, sir; before a Senate committee on similar bills to this.

Mr. SAYLOR. That testimony that appeared in the hearing this year?

Mr. STRAUS. Yes, sir; it was this year, sir.

Mr. SAYLOR. In regard to S. 5, S. 222, and S. 798?

Mr. STRAUS. That is correct, sir.

Mr. SAYLOR. Now, if the Bureau of Reclamation is authorized to proceed under this or similar bills, how will it affect the present projects of the Reclamation Bureau? By that principally I am interested in knowing whether or not by having artificial precipitation in one area, by any one of the two common methods now used, whether it will effect precipitation, the natural precipitation in other areas so that you might have a superabundance of water in one section, and a drought in another.

Mr. STRAUS. I might do that. The bill does not vest any authority in the Bureau of Reclamation in any way, and it is not proposed that under this bill that it be vested in the Bureau of Reclamation. It is in the Secretary of the Interior, but to respond to it would affect our present operations most markedly, but most beneficially in the area of new water, where the Government and the localities have heretofore made major investments in reclamation work, where they have

short supply, owing generally to the growth of the communities and new demands.

The chairman comes from an area where that is most marked, in the Salt River Valley, where probably the first great reclamation program was undertaken after the Reclamation Act was passed, and the development has been so terrific there that they are far beyond their water supply. We might get some more water in those reservoirs.

Mr. SAYLOR. Might it not also be that as a result of getting more water in those reservoirs that the natural precipitation which takes place in the eastern part of the United States, in which the Bureau of Reclamation is not concerned, might be vitally affected?

Mr. STRAUS. Indeed it might, but I have no positive knowledge on that, nor has anybody else. However, there is already one lawsuit or one charge to that effect officially filed. I think that something was brought before you, by the State engineer, or court, in Utah, in which somebody said somebody was taking Utah's clouds.

Mr. SAYLOR. Such as they have also had unnatural phenomena, such as snowfall, about 4 feet, in one of the Western States here recently, which was unheard of, the reason in which it occurred?

Mr. STRAUS. I believe that occurred up above Denver in the Colorado area if I remember correctly.

Mr. SAYLOR. That is correct. And it might create unusual flood situations that heretofore nature has sort of been able to handle by itself.

Mr. STRAUS. Well, it is certainly possible and the opinion of this Government was that it from time to time gave nature a slight assist in its States, in many types of flood-control works.

Mr. SAYLOR. That is all.

Mr. ENGLE. Our friend from Florida, Mr. McMullen.

Mr. MCMULLEN. I didn't have any questions. I thought the purpose of this bill was to make these experiments from time to time to determine the possible effects as far as possible. That is the comment I had to make.

Mr. ENGLE. The chairman, I think, had a question he wanted to submit.

Mr. MURDOCK. Our time is pretty short. Possibly this can't be answered, but I would like to submit the question and see if we can accumulate the information for the record a little later.

I think, Mr. Chairman, we haven't developed enough the possibilities of doctoring water at the lower end of a project, or river system, which has become saline through use or reuse, and has become intolerable to plant utilization, and make such water, although it may be hundreds of miles from the sea, useful again by this treatment.

As I understood the testimony yesterday from some witness, it wouldn't be necessary to have distilled water possibly; it wouldn't be necessary to purify it to the extent it would be good for human consumption, but it would be relieved of some of its salt content so that it might become again usable for irrigation.

Now, I am thinking of one illustration.

Mr. STRAUS. I am thinking of the same one, Mr. Chairman.

Mr. SAYLOR. Let's put it on the record. The Salton Sea might be a very desirable place to conduct that experiment.

Mr. MURDOCK. What I was thinking of, and I would like to see it done in the Salton Sea, surely, but the Gila River flows entirely across the State of Arizona, and every drop of water that it has has been utilized and it is as dry as a bone, but in utilizing the water it has been diverted and used and reused until you get down within a hundred miles of Yuma, where it joins the Colorado; the water is so salty, it has been utilized there for several years prior to the recent legislation, until the wells became so salty that you could smell them further than could see them, and I think, Mr. Commissioner, you gave that very testimony, or somebody from the Department did, and we have found that down in the Welton area, which some of you flew over recently, a rich agricultural area which had been well developed 25 years ago, was about to revert to the desert until the recent legislation, which brings in sweet water.

Now, is there anything in this desalting program that might take that water a hundred miles up the river from the Welton area, which had already become too salty to use, and make it usable from those wells that used to use it before, say 25 years ago?

Mr. STRAUS. Yes, Mr. Chairman. In the Welton-Mohawk area of southern Arizona, that is exactly the condition that exists, and there are processes by which that water can be purified short of complete distillation, but to an extent that it is both potable and usable for agricultural purposes.

The quality of water, as well as the quantity, is a matter of major anguish to many communities and to the Bureau of Reclamation. Even the Colorado River, we should point out, which is sometimes I believe a matter of occasional discussion before this committee, is not distilled water, but it is a fair quality of water.

One of the principal ways to answer the question directly is already in use in other countries, and that is by distillation and dilution of the badly contaminated or badly salted water, with the water converted in the same way you would convert sea water, a pure water, thereby lowering the parts of the injurious salts to a point of toleration, industrially, agriculturally and humanly. That is used today in the southern part of Israel where they are already engaged in exactly that practice.

Mr. MURDOCK. This is what I am thinking of: its relative cost. I talked to a man concerning the treatment of sewage, which is important, but sometimes a little disgusting to our discussion, but I find that they find that they can treat sewage from the city mains and do it at a certain cost, and make that treated sewage suitable for irrigation, or reclamation at a small cost.

Mr. STRAUS. This committee passed a bill to authorize exactly that thing in the case of Amarillo, in the Canadian River Act.

Mr. MURDOCK. This is the thing I wanted to get at: If you treat that sewage so that it can be used for domestic purposes, it will be a higher cost; at least two or three times higher but if you treat it to the extent that it can be used for human consumption, it must be a much higher cost, say, eight or ten times higher.

What I am trying to get is the relative cost of the treatment of saline waters at the lower end of the reclamation project at a tenth of the cost of distilling it for human drinking purposes. Is that possible or not?

Mr. STRAUS. Not confirming the figures, the principle is definitely possible, and that is one of the things that might be developed under this legislation, the hard figures on it, but it is possible by dilution of the polluted water to a point that it is usable.

Mr. MURDOCK. The dilution business is almost out, if you don't have something to dilute it with. That is the point. The thing I wanted to emphasize is this: that the degree of purification in the ascending scale is relatively more expensive, maybe "as the squares of the difference," for all I know, or something like that.

Mr. ENGLE. May I interrupt you to say we are about out of time and I assume Mr. Bow and perhaps Mr. Harrison have some questions.

Mr. BOW. I have no questions.

Mr. ENGLE. How about you, Mr. Harrison?

Mr. HARRISON. No questions.

Mr. ENGLE. If that is the case, perhaps we can dispense with any further testimony, Mr. Straus, unless you have something else. We will meet tomorrow morning to hear Mr. Barnes and Mr. Brown, Mr. Barnes of the Research Administration of the Department of Agriculture, and Mr. Brown, Chief of the Division of Forest Fire Research, and the chairman has indicated he would like a full committee meeting at 11 o'clock.

I take it we can wind this thing up in an hour in the morning. Will you be available tomorrow morning, Mr. Straus?

Mr. STRAUS. If called and necessary, I am at the committee's service. I want the committee to bear in mind, while I have talked from the point of view of reclamation, naturally this bill comes before the committee as a cooperative program under executive direction for many agencies of the Federal Government would have most positive interest in this, including the armed services, Weather Bureau, Department of Agriculture, Bureau of Standards, and many other established agencies.

Mr. ENGLE. If there are no further questions, we will not ask Mr. Straus to return, because we know he has other obligations, and the meeting will stand adjourned until 10 o'clock in the morning, at which time we will plan to terminate our hearings at 11 o'clock so the full committee can meet.

(Whereupon, at 12 o'clock noon, the committee adjourned, to reconvene at 10 a. m., Thursday, June 21, 1951.)

PRODUCTION OF FRESH WATER FROM SEA WATER

FRIDAY, JUNE 22, 1951

HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
SUBCOMMITTEE ON IRRIGATION AND RECLAMATION,
Washington, D. C.

The committee met at 10 a. m., pursuant to adjournment, the Honorable Clair Engle (chairman of the subcommittee), presiding.

Mr. ENGLE. The Subcommittee on Irrigation and Reclamation will be in order for the further consideration of H. R. 6 and H. R. 7 introduced by Congressmen Phillips and McKinnon, respectively.

We had, at the termination of the last meeting, two witness to be called. Mr. Carlton P. Barnes, Agricultural Research Administration and Mr. Arthur A. Brown, Chief of the Division of Forest Fire Research, United States Forest Service.

Mr. Barnes, are you here?

Mr. BARNES. Yes.

Mr. ENGLE. Will you care to come forward, sir? We will be glad to have your statement.

I understand Dr. Reichelderfer of the Weather Bureau is here today. We will get to you next.

Now, Mr. Barnes, the House goes into session at 11 o'clock. Do you have a prepared statement?

Mr. BARNES. I have a statement from Mr. Brown which he asked me to read because he wasn't able to be here. I have an oral presentation I would like to give before that.

Mr. ENGLE. How long is Mr. Brown's statement?

Mr. BARNES. It would take about 3 minutes.

Mr. ENGLE. You may proceed, sir.

STATEMENT OF CARLTON P. BARNES, AGRICULTURAL RESEARCH ADMINISTRATION

Mr. BARNES. We in the Department of Agriculture believe that the development of a cheap process for extracting fresh water from saline water would have great benefit to agriculture in certain water deficient areas.

Mr. ENGLE. Would you care to give a little explanation of your background, Mr. Barnes? What is the Agricultural Research Administration and in what way is your department connected with this problem?

Mr. BARNES. The Agricultural Research Administration is the agency which carrys on through six bureaus most of the physical and biological research in the Department of Agriculture. It carries on all of the physical research except the research in forestry.

We have no technical competence in this field. We are interested in it only from the standpoint of the benefits that agriculture would get from it. We have no meteorologists in the department since the Weather Department left us and no interest in the problem of extracting fresh water from sea water.

Mr. ENGLE. Is your interest in converting sea water to fresh water or extracting or from precipitation?

Mr. BARNES. Our main interest is in artificial rain production and the other aspects of weather control but we can see benefits that could come from cheap extraction of fresh water from sea water so we have an interest in that also.

Mr. D'EWART. Does your bureau make any research of taking the salts out of the irrigation water or alkaline water?

Mr. BARNES. Yes we do. We have a salinity laboratory at Riverside that studies the quality of irrigation waters more or less throughout the West and studies the effect of the salinity of those waters on crop production and on soil properties.

Mr. D'EWART. I would think that would be of more immediate importance than the larger problem of salt out of sea water as far as agriculture is concerned.

Mr. BARNES. It could conceivably be so. I wouldn't want to predict which would be the greater importance.

At any rate we think that the prospects are good enough so we believe that the research ought to be undertaken.

Mr. D'EWART. Do you make those studies both with respect to salt-resistant plants and also with regard to removal of alkaline out of these waters?

Mr. BARNES. That is correct. We study the tolerance of plants and methods of reclamation of saline lands. That is correct.

Mr. D'EWART. Are you making considerable progress with those studies?

Mr. BARNES. I think we could say that, yes. I think we have methods that are frequently successful in reclaiming saline lands. We learned a good deal about the salt resistance of plants.

Mr. D'EWART. They are a major problem with a good many irrigation projects.

Mr. BARNES. That is certainly true. We also believe there is a good deal of research needed before we are in a position to predict the practical possibilities of artificial rain making. Our farmers are asking our county extension agents in many places whether they are justified in paying rain makers and we just can't tell them. Of course it is true rain often follows cloud seeding but it often rains without cloud seeding and we don't know what to say about that. We are also interested in the other aspects of weather control, namely those that involve cloud dissipation. We think perhaps that holds possibilities in reducing damage from lightning and from hail, perhaps also from windstorm and floods and erosion.

Earlier in the year, Senator Ellender, chairman of the Senate Committee on Agriculture and Forestry asked us for a report on S. 798, Senator Case's bill, which would have authorized our Department, Agriculture, to carry on research in the artificial production of rain. We reported that we favored the enactment of that bill with certain amendments.

About the same time, the Budget Bureau asked us for a report on S. 5, which is identical with the two bills we are considering today, and in reporting on that, we said we had endorsed S. 798, but if the various committees that were considering weather control in the Congress wanted to use S. 5, as a use of expanding federal authorization in weather control research we thought it ought to be amended to give our department, the Department of Agriculture, some authorization to do work on the various aspects of weather control.

Mr. ENGLE. What is the difference between these two bills? Does one give authority to Agriculture and the other to Interior?

Mr. BARNES. That is the difference between 798 and S. 5. Seven hundred and ninety-eight gives authority only to the Department of Agriculture. I would like to emphasize in saying that we do not want to have primary responsibility for research in this field. We think perhaps that is more appropriate for the Weather Bureau to have, and we merely wanted to have some authorization that would not prevent us from doing work if we felt it needed to be done and nobody else was doing it.

Mr. BOW. May I interrupt there? Have you examined these bills, H. R. 6 and H. R. 7?

Mr. BARNES. Yes.

Mr. BOW. Don't you feel the language in the bills, under section 2, "to cooperate with any other Federal, State, municipal department or agency or instrumentality," and under F, "to provide assistance in carrying them out," and so forth, and also there is authorization here to pay for that and to contribute, don't you feel that language is sufficient, that the Department of Agriculture would be given the opportunity to carry on their tests and do the things they might want to do in this bill?

Mr. BARNES. There is no way of knowing whether we would or not. I don't believe we would consider that would be entirely adequate.

Mr. BOW. You think it should be definitely set forth in the bill, that the Department of Agriculture should be able to carry on their work?

Mr. BARNES. That is our recommendation.

Mr. BOW. Then we have two agencies perhaps acting independently, doing the same thing, and that brings about a lot of expense in Government, duplicating and overlapping of experience and work within these departments?

Mr. BARNES. Yes. I might mention the other recommendation we made with respect to both these bills and that was that we thought the bills ought to specify that both Interior and Agriculture should cooperate with the Weather Bureau in the conduct of this work and then we suggested perhaps that the committee—we suggested the committee should perhaps consider the desirability of having the bill provide that the Weather Bureau be a coordinating agency in all of this weather-control work, in view of the staff of meteorologists that agency has and its experience, and the technical competence in the field of meteorology.

Mr. BOW. Certainly, I think we should have the cooperation of various departments and agencies of Government that have some experience in this field but it seems a bit ridiculous to me that the Congress has to spell out and give each one authority to go their own

way, without having someone responsible and under this bill, it is the Department of the Interior. Is there such friction in the executive departments under the head of the President that the Congress has to come around and specifically give these different agencies authority to do these jobs?

Mr. BARNES. Well I don't know, sir. We think that we would feel a little better if we knew that we could carry on certain aspects of this research and in the Forest Service statement I shall tell you something about a particular interest we have. We think we would feel a little better if that authority existed clearly so there would be no doubt about it.

Mr. ENGLE. I am not so sure. The primary responsibility for this should be in the Interior Department.

Mr. BOW. But why should we give this same authority to these agencies so they can carry on independently? I think that is where we get the high cost of Government. There are many agencies where the same job is being done by various agencies and surprisingly enough they come up with various answers.

Mr. ENGLE. Collateral authority we don't like. We have the same authority in three or four different agencies. And they exercise their authority independent and there is a tendency for them each to try to build up a group of people to operate the particular activity. I am not so sure but what we shouldn't separate artificial rain making from sea-water research and put it in a separate bill.

Mr. BOW. I might say to the chairman that I have compared these bills and I would like to see the separation of these two projects.

Mr. ENGLE. I was thinking of an amendment to these bills. I am not so sure they go together. I recognize the Interior Department would probably be as good an agency to handle the over-all problem of sea-water conversion. It would seem to me the Weather Bureau already has a staff of very competent people dealing with cloud formations and all that sort of thing and of course if that power was put in the Department of Commerce under the Weather Bureau as a separate matter they would be given the same authority the Interior Department is given here, namely to correlate the work of other agencies, including the Department of Agriculture, but you have somebody who is the head of it, somebody who is responsible for it and somebody who has the authority to say who is going to do what whenever you set up a program like this. If you don't do that then the thing grows like Topsy.

Mr. BOW. It provides that various agencies will be taken in and work on this.

Mr. POULSON. I can see if this rain making is developed and we turn it strictly over to the Department of Interior, that the Department of Interior will be accomplishing or achieving what they have been trying to do all the time, to get their foot into the door and get a dominant control over the Department of Agriculture, because they will have rain making in areas where the Department of Interior is not active today, and in agricultural areas where they need rain and where they are not active and they would just love to get in that territory and start dictating policies which at the present is in the realm of the Department of Agriculture. I can see why the Department of Agriculture should have great concern over this bill and why they should be interested in seeing that these powers are defined

because pretty soon we will see the Bureau of Reclamation all over the country, whether they are needed or not, and we have enough trouble with them where they are supposed to operate.

Mr. D'EWART. Mr. Chairman, I think as far as the present witness is concerned, certainly it is a division of the Department of Agriculture's responsibility to make a study of the effects of alkaline salts on soils and on plant growth. If we are going to divide this up, that part of it should undoubtedly be in the Department of Agriculture. That is your job primarily?

Mr. BARNES. Of course we figure we have all the authority we need on that particular problem and we are not seeking any authority to put up demonstrations on how to make fresh water out of salt water, of course.

Mr. ENGLE. Just what authority do you want?

Mr. BARNES. We would like authority to do some research on weather control, not only the rain-making aspects but on these other aspects, for cloud dissipation to reduce lightning and, as some of you know, I think in the Northwest the principal cause of forest fires is lightning. We have some encouragement from Dr. Schaefer that we can accomplish something in that regard.

Mr. D'EWART. Isn't there an experimental laboratory now on lightning in Utah some place? And the effects of it?

Mr. BARNES. I don't know about that.

Mr. ENGLE. That is a new field. Now we are getting into something else. We are going to learn to settle dust here pretty soon.

Mr. BARNES. Our recommendation with respect to both these bills is they can be expanded to permit us to work not only in rain-making but what you might call negative aspects of rain control, lightning, hail damage, windstorm, and erosion damage and we think the possibilities there are almost as great as they are in the rain-making aspects.

Mr. ENGLE. That may be true. Let's have one more at a time.

Mr. D'EWART. I understand there is a study going on in Utah in regard to lightning at the present time.

Mr. BARNES. That may be. I am not informed about that.

Mr. D'EWART. I think I am right.

Mr. MURDOCK. Mr. Chairman.

Mr. ENGLE. Mr. Murdock.

Mr. MURDOCK. Mr. Chairman it depends upon the research work, the nature of the development as to who can do it best. I am thinking right now of some expansion and new development in the field of agriculture, and I was hoping that we might have at least 15 minutes of our time this morning to demonstrate that.

There are a lot of new developments which are being carried on by private enterprise, and I am going to call your attention to one in about a half hour, that can best be done by the stimulus of private enterprise. However, if it is a big thing that requires a vast investment, without a definite program, that is another matter.

Mr. BOW. That sounds like Government, a vast big program, and expenditure without a program.

Mr. MURDOCK. But you can't expect private enterprise to do some of these things. They are doing it in regard to desalting sea water and I hope that before we conclude this we will hear some of the men in industry which will give some light on this.

Mr. ENGLE. Let's hurry along here because we have one more witness.

Mr. BARNES. I have copies of our reports on S. 798 and S. 5 which I can submit. They were submitted in connection with the Senate hearings. If you would like them I have them here.

Mr. ENGLE. Those are the official Department reports?

Mr. BARNES. Yes.

Mr. ENGLE. Without objection, they will be put in the record at the same point at which the reports of the Department of the Army and Department of the Interior and the other reports appear so that the reports will all be in one place.

Mr. BARNES. With you permission I would like to read Mr. Brown's statement concerning the interest of the Forest Service in this legislation.

Mr. ENGLE. You may proceed.

STATEMENT OF A. A. BROWN, UNITED STATES DEPARTMENT OF AGRICULTURE (AS READ BY C. P. BARNES)

Mr. BARNES. A statement by the Forest Service was submitted as part of the departmental testimony in respect to S. 798. This statement today has a similar purpose—to explain briefly the potential relation of cloud seeding and other forms of weather modification to the work and responsibilities of the Forest Service.

Those aspects of the bill relating to saline waters have been passed on favorably by the interdepartmental committee in which the Department of Agriculture has participated and to which you have been referred in previous testimony by Mr. Lineweaver. They are outside Forest Service responsibility.

The following comments refer only to the proposed extension of research in weather modification by cloud seeding.

As administrator of the 181 million acres of public property comprising the national forests, the Forest Service has an interest in anything that may affect the amount, distribution, or timing of precipitation on these lands, since tree and plant growth and forage production are very closely linked to what happens to the moisture supply. This is the wild land counterpart of the interest of the rancher and farmer in moisutre for his crops and pastures.

Of equal importance to the public interest is the yield of water from the mountain watersheds within the national forests. They include the headwaters of most of the important drainage basins of the country and account for 53 percent of the water available for irrigation and power development in the 11 Western States. Proper management of these important watershed lands for maximum yield of usable water is regarded as one of the most important responsibilities of the Service.

Research in stream flow and in watershed management has been carried on by the Forest Service for the last 30 years. Through such work and our participation in the flood-control programs of the Department, we are, of course, fully familiar with the importance of water and with the water problems both in the West and East.

They have already been ably presented here and I am sure they need no further elaboration before the committee. I think it is sufficient to say that watershed relationships are highly complex and are easily

upset. Any possibility of even slightly modifying the amount or geographic distribution of the winter snow pack or of the amount and seasonal distribution of rain becomes highly important to the agency responsible for actual management of the watershed, and will undoubtedly have important effects downstream.

Another special interest growing out of the work of the Forest Service is the possibility that cloud seeding might have value in reducing the number of lightning fires by dissipating local storms at their source in the mountains, in reducing forest-fire hazards and on certain occasions in assisting in the control of going forest fires.

Many other potentials that involve all aspects of land management and forest research can also be conjectured if significant artificial modification of the weather is accepted as already a fact. But I believe the above is sufficient to illustrate that the potential is much broader than direct precipitation of rain or snow at desired spots in commercial quantities.

For such reasons, the Department in reporting on S. 798 recommended that the Secretary of Agriculture have clear authority to perform research in methods of weather control as it affects agriculture. The Forest Service believes this position is equally applicable to H. R. 6 and 7 and S. 5.

We believe, too, that a distinction is appropriate in the research needed in this field. The more fundamental research in cloud physics has been progressing rapidly in the last few years, but its application to local situations is still unknown though eagerly sought by interested groups. Many are willing to gamble in the meantime.

The form of research the Forest Service would seek to do at the present stage would consist of careful field testing of the techniques and principles already developed by the physicists and meteorologists to determine useful applications. Such an extension of research should be on a cooperative basis among interested agencies and ought to supplement rather than duplicate the very fine cloud physics experiments and investigations that have been in progress in recent years. We believe it should include full participation by the Weather Bureau, of the Department of Commerce and others qualified in this field along the lines recommended in the Department's report on S. 798.

Its aim would be to test the practical possibilities of putting the results of more fundamental research to use under different sets of local conditions. We have had some plans for lightning fire prevention by cloud seeding ready to go for the last 3 years but have lacked funds to proceed.

Mr. ENGLE. Thank you very much. We appreciate that statement and we appreciate your being here. We realize, Mr. Barnes, that you have been here for 3 days and we can't always be sure how long these witnesses are going to testify, so it necessarily involves some delay. I hope you found the testimony of the other witnesses informative and the hearings not entirely without interest.

Mr. BARNES. I did, sir.

Mr. ENGLE. I think perhaps we will seriously consider separating the rain-making aspects of this legislation from the sea water. That is one thing I wanted to submit to the committee at the proper time. Dr. Miller?

Mr. MILLER. I wanted to ask one question. You spoke about cloud-seeding operations. You were ready to go for 3 years and lacked funds. Is there any effort being made by departments of the Government to coordinate the work already being done by private groups on cloud seeding? For instance, in western Nebraska and Wyoming there is a group spending a considerable sum of money on cloud seeding. I think it is happening in Arizona and several other places. Is there any group picking up the information that must be available from experiences of these private groups, trying to evaluate that information?

Mr. BARNES. I am not aware that there is any. I believe it was the purpose of Senator Anderson's bill to provide such a coordinating responsibility.

Mr. MILLER. You realize we should encourage private industry to go ahead?

Mr. BARNES. Yes.

Mr. MILLER. They should explore the possibilities of cloud seeding and there should be some agency some place to pick up that information and sort of evaluate the findings.

Mr. BARNES. I agree that that is important.

Mr. ENGLE. Thank you very much.

Mr. BOW. Mr. Chairman, may I ask one question? What is your opinion as to whether or not the companies should be licensed?

Mr. BARNES. I think they should be licensed. I think there should be some track of what they are doing, where they are doing it, and some way of recording the results of what they may have done.

Mr. BOW. There should be some licensing as to responsibility, too? I understand some of these people rather take advantage, throughout the country, without having proper equipment. Perhaps danger might come about. Do you think they should make some report, through licensing of operations of that kind?

Mr. BARNES. Yes; I believe they should.

Mr. ENGLE. Thank you very much, Mr. Barnes. We appreciate your statement. Now, Mr. Reichelderfer, you are the Chief of the United States Weather Bureau?

Mr. REICHELDERFER. Yes.

Mr. ENGLE. Do you have a prepared statement?

Mr. REICHELDERFER. Yes, I do.

Mr. ENGLE. You may summarize your statement.

Mr. REICHELDERFER. The statement itself is already very largely summarized. I will be glad to summarize it if you prefer but I think the statement will only take 3 or 4 minutes to read—no, it will take a little longer than that.

Mr. ENGLE. Proceed, sir.

STATEMENT OF F. W. REICHELDERFER, CHIEF, THE UNITED STATES WEATHER BUREAU

Mr. REICHELDERFER. What I have tried to do, Mr. Chairman, is summarize the points that I think are important insofar as the Weather Bureau is concerned in this legislation.

These provisions of H. R. 6 and H. R. 7 which pertain to utilization of ocean water for agricultural and other purposes would more or less affect the natural hydrologic cycle and the present conditions of

humidity, cloud, and precipitation in the atmosphere, at least locally, and would in that case have a bearing on the work of the Weather Bureau.

The possibility of augmenting the country's water resources by drawing on the inexhaustible supply from the sea is of interest to us also because of its influence on the services of the Bureau and on questions about evaporation, precipitation, and other meteorological factors in relation to the very serious problems of water supply in regions where the water shortage is critical.

We believe the research and development for utilization of sea water and other saline waters should be strongly supported. In this proposal there is no question of possibility—the purification of saline water on a small scale in common practice and the problem is principally one of economic practicability. I believe the National Bureau of Standards in expressing its views elsewhere jointly with the Weather Bureau in comments for the Department of Commerce has stated its interest in the provisions of these bills and its recommendations in favor of studies of the physical and economic aspects of recovery of waste water and distillation or chemical purification of saline waters.

On the other hand, the second general line of attack proposed in H. R. 6 and H. R. 7—that is, rainmaking—involves the question of possibility as well as that of practicability. There is a limit to the amount of moisture in the air that might be precipitated by artificial means, and usually the moisture supply is not in the right place where it is needed as rain. There are also questions as to the physical circumstances under which precipitation can be artificially induced to form under conditions which do not produce it as result of natural causes. No one knows how much rain or snow can be added in this manner. The Weather Bureau is intensely interested in these questions and strongly favors further studies to determine the facts.

Much has been said and written about rainmaking. Since the committee has already heard discussions of the subject in general, it is not necessary for me to repeat anything about the methods employed in rainmaking or about the commercial operations in this field and the claims relating thereto, some of which have been rather extravagant.

Perhaps there may be specific questions with reference to the work of the Weather Bureau on this subject and if there are, I shall be glad for the opportunity to comment, but in this prepared statement I shall limit my remarks to the principal meteorological points which appear not to have received the attention which is merited by their importance in this legislation.

The committee is doubtless aware that there are certain friendly differences of opinion among the experts as to the practical possibilities. Those differences relate primarily to quantitative question, that is, how much can the quantities of rain or snow that fall from natural causes be increased by artificial means; and how frequently are atmospheric conditions suitable for artificial inducement of precipitation? Are these occasions sufficiently frequent in regions where there is a shortage of water to permit rainmaking to become a reliable source of water when most needed?

There is at least one point on which all experts and rainmaking operators apparently are agreed, and this is that much more extensive research and experimentation are necessary to obtain the answers to these questions.

I believe all experts are also agreed on the view that the problem is primarily a question of quantity and frequency.

It has been conclusively demonstrated in the laboratory and in the atmosphere that cloud droplets at temperatures below freezing can be transformed into ice particles or "snow" by "seeding" with dry ice or silver iodide. This "snow" is precipitation and under proper conditions it becomes light rain as it falls, but the amount obtainable even by converting all of the droplets in a very large cloud into snow crystals is hardly enough to moisten the ground.

In principle therefore, there is no question that sub-cooled clouds can be induced to precipitate part of their moisture through seeding and this means that rain can be induced artificially at least in small quantities. But it is quite a different matter to set up the large-scale circulation of air and the inflow and ascent of water vapor into the cloud which is necessary to produce showers or rain in appreciable quantities. This involves the dynamics of showers and storms and brings in factors of much greater magnitude, unless, of course, there is a catalytic or trigger action which has not yet been substantiated. Some such action may come into play occasionally, but probably not frequently.

When the efficacy of dry ice as a cloud-nucleating agent was first described by Langmuir and Schaefer in 1946, its significance in meteorology was promptly recognized by meteorologists and the Weather Bureau among others began extensive experiments to determine its value in research in weather problems.

When we reached the point where it was obvious we could not answer the quantitative questions except by a new approach to the research, we discontinued the field experiments and concentrated on the design of better experimental techniques and a study of some of the fundamental obstacles. The Bureau proposed a plan for further research last fall and is now working on ways and means to carry it on.

There is another point on which probably most scientific experts would agree. The answer to the question as to how much the natural rainfall can be augmented by seeding involves a comprehensive study of the causes and mechanics of showers, thunderstorms and other atmospheric disturbances which result in precipitation.

This question in turn enters into the most fundamental problems of meteorology and these problems are the subject of Public Law 657, Eightieth Congress. Under this enabling legislation the Weather Bureau has been working on these meteorological problems as rapidly as possible and considerable progress is being made. We recognize the great urgency of an early solution and have urged greater effort toward this goal. To some extent the Korean war has interfered with the organization of facilities which we expected to have available for further experimentation in cloud and shower studies.

From the foregoing statement it is seen that enabling legislation for research which is basic to rain making is already ample and that the problems are those on which the Weather Bureau has been and is working with all the facilities it can get together for the purpose. The problems are meteorological problems and are part and parcel of the Bureau's functions and responsibilities.

Enabling legislation which would introduce these problems as a new responsibility in another department of Government would certainly necessitate the establishment of meteorological staffs and

facilities which under present circumstances are already in short supply. In the study of rain making possibilities we have kept closely in touch with engineers in the Department of the Interior, and have enjoyed very close cooperation I would like to say, who are interested in this subject and it is our understanding that it was originally the expectation that the Weather Bureau would cooperate in the meteorological research under the plan.

We believe that close cooperation will be necessary to avoid unnecessary duplication, and it occurs to us that perhaps additional enabling legislation is unnecessary at this time in view of the provisions of Public Law 657 to which I have referred.

We certainly are strongly in favor of plans that will bring definite answers to the important questions of rain making as soon as possible and we believe that the plans proposed by the Weather Bureau for this experimentation will prove to be adequate.

I should explain that the law to which I referred, Public Law 657, does not specifically mention rain making but in carrying out the functions and the intent of that law we would, we feel sure, get all the answers that are necessary to determine what the practicabilities are in rain making. The law of course does not permit the Weather Bureau, nor are we seeking authority, to be the operating agency in producing rain or applying rain to practical problems throughout the country, which may be the function of other departments.

I have not included a complete history of the results of other Bureau research. That is fairly well covered in the hearings on this subject with S. 5. I will be glad to furnish that for the record if you desire but I thought perhaps you didn't care to have it in this record.

Mr. ENGLE. It isn't necessary because we are going to ask our committee consultant, in cooperation with the technical men on the other side, to brief the information in the Senate hearings, which are not so readily available in their present form and in order not to duplicate the work which is done over there. I think perhaps we can get the information out of the Senate hearings, in a boiled-down condition, which would be informative to the committee without requiring a complete duplication of the Senate hearings.

Now your statement has been very interesting and I intend at a little later time to ask this committee to pass on the question as to whether or not the rain-making aspects of legislation shouldn't be separated from the sea water. They are two very big fields and I am not so sure we can bite off and handle both of them in one piece of legislation.

I think the mechanics, as far as Government procedure in the handling of the two problems, could very well be different. It may be the committee might think the handling of the rain making might be in the Weather Bureau and not in the Department of the Interior. It is hard to believe that we should set up a new agency to do this when you have people who have spent a lifetime on these problems in your department. I know you have men down there who have made a lifetime study of it and it seems to me there will have to be a duplication of technical knowledge to a certain extent before any other agency can even equal what your people know at the present time.

As a consequence of that it will probably be necessary to ask you to come back before this committee to give us your views at a later

time and for the time being we certainly appreciate your appearance. Are there some questions?

(Discussion off the record.)

Mr. ENGLE. What I am saying is, the Weather Bureau operates facilities for the CAA, and they have been in this field for years, and have men I know who have spent a lifetime studying why rain occurs, and why cloud formations form, and what happens after they do form, and all of that kind of business, and I am just not so sure that we can package this thing all up in one detail and put it into the Department of Interior without sacrificing, or at least duplicating, a good deal of the experience and knowledge already acquired by these people in the Weather Bureau, over many years of very careful work and painstaking research.

Are there any further comments or questions? If not, we very much appreciate your appearance here, Mr. Reichelderfer. We are sorry that you have been called back from time to time, but we can't judge how long each of these witnesses will appear, and in the light of what I have previously said, we probably will ask for your further advice in this matter.

Mr. REICHELDERFER. I will be available, Mr. Chairman.

Mr. ENGLE. Thank you very much. We appreciate your coming.

Now, gentlemen, that brings to an end this phase of the hearing and if there is no objection, when we set up the next hearing, I propose to call a selected number of scientists, who have gone into this matter of converting sea water, and at that time I will ask this subcommittee to pass on the question of whether or not we should try to bite off both of these subjects or whether we should separate them, and try to handle the sea-water proposition in one piece of legislation, and take up the rain-making matter later. They both are very big and very complicated fields.

The chairman has asked to have a short executive session at a quarter of 11. We are 3 minutes late, Mr. Chairman, but that is practically on time for a Member of Congress.

Mr. BOW. Before leaving this, are you going to ask anyone from the Navy to come in to testify on their experience on this sea water?

Mr. ENGLE. I think we should, Mr. Bow, and before I formulate that list I will ask Mr. Carr to check with you and any other members of the committee as to suggestions as to who we call in. We can't handle too many and we shouldn't duplicate the Senate hearings. We can summarize those, and perhaps there are one or two who are particularly informative in their testimony. We might call them. I will ask Mr. Carr at this time to boil those hearings down in conjunction with the Senate committee staff so they will be of value to our committee without having to go through 600 pages of testimony.

If there is nothing further the subcommittee will be adjourned until further notice, and the meeting will be turned over to the chairman of the full committee.

(Whereupon at 10:50 a. m. the subcommittee was adjourned to call of the Chair.)

PRODUCTION OF FRESH WATER FROM SEA WATER

TUESDAY, MARCH 11, 1952

HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D. C.

The committee met, pursuant to notice, at 10 a. m., the Honorable Clair Engle, presiding.

Mr. ENGLE. We turn now to the first order of business for this morning, consideration of H. R. 6578, which is a bill introduced at the instruction of the Subcommittee on Irrigation and Reclamation, to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

Mr. McKinnon has introduced an identical bill, H. R. 7185.

Mr. Phillips has also introduced a similar bill, H. R. 6704. Mr. Phillips is here. Mr. Phillips, we would be glad to have you come forward and join the committee in consideration of this legislation.

Mr. PHILLIPS. Thank you, very much.

Mr. ENGLE. Mr. McKinnon, I understand, is not in the city at this time.

Perhaps it would be beneficial to give you a short résumé, although most of you are familiar with the history of this legislation.

This legislation was introduced in the House Subcommittee on Irrigation and Reclamation.

The bill at one time was tabled. Thereafter it was withdrawn from the table and the committee directed very substantial amendments to be made, in effect rewriting the legislation, and directed the chairman of the subcommittee to draft this legislation pursuant to the instructions of the subcommittee and introduce it, with the understanding the legislation would be drafted and introduced describing the principles set forth by the subcommittee.

The subcommittee voted the bill out and to the full committee, where it is under consideration at this time.

The bill, as directed to be redrafted by the subcommittee, is now before you in the form of H. R. 6578.

The previous bill by Mr. McKinnon is H. R. 7. Without objection, it will be tabled.

And without objection, H. R. 6, which was a companion bill to H. R. 7, introduced by Mr. Phillips, will also be tabled.

There being no objection, H. R. 6 and H. R. 7 are tabled.

I make the statement for the record that both Mr. McKinnon and Mr. Phillips have indicated their approval of the new draft and have

cooperated with your chairman of the Subcommittee on Irrigation and Reclamation.

The bill is currently before this full committee for consideration.

We had not anticipated the taking of any further testimony but I believe that Mr. Bow has a letter or statement which he desires to make a part of the record.

Mr. Bow, would you make a statement what that is?

Mr. Bow. I have a statement of the Griscom-Russell Co., of Massillon, Ohio, that I would like to have made a part of the record of the hearings of the subcommittee.

Mr. ENGLE. Without objection, it is made a part of the record.

(The statement referred to is as follows:)

STATEMENT OF THE GRISCOM-RUSSELL CO., MASSILLON, OHIO

Mr. Chairman and gentlemen of the committee, I am Kenneth B. Ris, president of the Griscom-Russell Co. of Massillon, Ohio. We are very much interested in the legislation you are now considering, namely, H. R. 6578.

For many years we have worked closely on sea water distillation problems with the Shipbuilding Division of Bethlehem Steel Co. The 10 numbered paragraphs given below are taken from an earlier statement we made on similar legislation last year. Following that we are quoting excerpts from a statement made by Bethlehem Steel at about the same time. We respectfully request your consideration of the facts we are presenting:

1. Water shortages resulting from increased demand or from occasional dry spells may be alleviated in a number of ways. In some localities artificial rain making may be useful while in others additional dams and aqueducts might be the best solution. For those communities located near the sea, the conversion of sea water into fresh water offers considerable promise. Many methods have been proposed for accomplishing this conversion but there is wide agreement that distillation is by far the most reliable. It is the only method which is sufficiently well developed to offer an immediate solution. It is at least comparable in cost and has certain advantages not possessed by any of the other methods. Even for those communities removed from the sea, distillation offers a solution to the problem of drinking-water shortages resulting from contamination of normal water supplies in the event of war.

2. Production of fresh water from sea water by distillation is a very old art. We have been engaged in this art since the very inception of our company over 80 years ago. In cooperation with the United States Navy we have made many advances since World War I and during World War II so that now we know a great deal about the production of pure drinking water from sea water, particularly by the low pressure distilling method which has proven to be the easiest and simplest to operate.

3. Between January 1, 1935, at which time the modern shipbuilding program got under way, and June 1, 1950, our company produced 3,478 distilling plants of low-pressure submerged-tube type ranging in sizes from 4,000 gallons per day to 60,000 gallons per day, having a total rated capacity of 38,066,000 gallons per day. We received several commendations from the Bureau of Ships and the Bureau of Medicine and Surgery praising the successful operation of our plants.

4. In addition to the marine work we have done a great deal of work on land-type plants evaporating sea water, but most of these have been at higher pressure. One typical plant has now been in successful operation on the island of Aruba for many years producing about 450,000 gallons per day, starting with high pressure steam in the first effect and going down to low vacuum in the final effect.

5. As a result of recent widespread interest in this subject, a number of novel distilling plant arrangements have been proposed. Among these, one would combine distilling plants with solar heaters, another would combine them with thermal difference power plants, etc. Quite apart from the natural inherent limitations in the possible application of these methods, none is so well developed to permit immediate relatively large scale installations to be made now. A great

deal of additional time and effort necessarily must be spent on laboratory and small-scale research work.

There are two distillation methods which have been well developed, and which reasonably can be expected to produce relatively large quantities of potable water now. These are (1) low-pressure multiple-effect distilling plants associated with back-pressure turbines, and (2) engine-driven compression-type units.

6. Our preliminary studies have shown that low-pressure evaporators could be associated with back-pressure turbines using multiple effect to economize on fuel and the installed cost of such an evaporator plant would be about $2 per gallon per day when such plant was built in connection with a 50,000-kilowatt turbine which would produce 4,650,000 gallons per day of distilled water. The extra fuel consumption over that normally required to produce the power would cost approximately 35 cents per 1,000 gallons of fresh water produced. Improvements which may be effected as a result of further development work could well reduce this fuel cost to the neighborhood of 30 cents per 1,000 gallons.

7. For peacetime operation, one large central plant would no doubt be the cheapest thing which could be installed, but this is open to other disadvantages in case of war.

8. If it were decided that emergency operation under threat of attack during war is the most important, then widely dispersed plants might be the best answer. For a large number of independent units engine-driven compression-type plants similar to those used during the war might offer the greatest safety, although the over-all cost would probably be greater. So far such plants have been built in relatively small sizes and considerable research would be required before plants large enough could be built. In particular, the older type of compression plants, because they operated at relatively high pressures, were subject to fouling. A low-pressure compression-type plant has been designed and much development work has already been accomplished. This would be a real improvement because the low-pressure plant would operate for longer periods of time without requiring cleaning.

9. For the combination of large volume production at reasonable cost together with safety, perhaps distilling plants should be located adjacent to all of the existing power plants, plus a certain number of isolated compression plants remote from the power plants which could still operate in case the power plants themselves were attacked.

10. For distillation plants of the types mentioned above we have advanced beyond the necessity of doing laboratory research. What is now required is the letting of a contract to a qualified manufacturer of distillation units, such as ourselves, which would permit us to proceed at once with the construction and operation of large-scale pilot plants. For this purpose we would suggest a flash-type plant capable of producing about 1,000,000 gallons per day and a compression-type plant capable of producing about 50,000 gallons per day. Our engineers are fully competent to design such plants and we know that we could operate them successfully and, therefore, develop data which would enable us to develop full-scale plants on the most economical basis for the requirements of a large city.

EXCERPTS FROM STATEMENT BY BENJAMIN FOX, SUPERINTENDENT, ENGINEERING AND DESIGN, BETHLEHEM STEEL CO., SHIPBUILDING DIVISION, CENTRAL TECHNICAL DEPARTMENT, QUINCY, MASS.

"Introductory

"In the present state of our knowledge the production of large quantities of fresh water from sea water is practicable only through distillation. This requires the application of heat and a corresponding consumption of fuel; nearly all of this heat is used in vaporizing the sea water but a minor portion is required for developing the power to operate pumps and similar accessories. While any of the common fuels could be used the numerical values in these notes are, for convenience, based on oil fuel derived from petroleum.

"In discussing the performance of distilling plants it is convenient to use, as a measure of fuel efficiency, the ratio of pounds of fresh water made to pounds of fuel consumed. This ratio varies widely with the type of plant and the manner in which the equipment is integrated with other activities such as the propulsion of ships or the generation of power.

"On shipboard, where sea-water distillation has had its principal application, the heating medium is usually steam and the fresh water to fuel ratio usually

ranges from about 25 to about 75 depending on the complexity and the cost of the distilling plant and on the manner in which it is tied in with the propulsion plant. A ratio of about 50 would be considered typical of excellent practice.

"A type of plant is available in which the heat required is supplied by compression of vapor through mechanical or electrical power rather than by direct transfer from steam. This type may afford fresh water to fuel ratios as high as 200; and it has been applied on shipboard and elsewhere in large numbers. On ships it is usually limited to very small capacity (up to 2,000 gallons per day) and to installations where there is no adequate boiler plant for steam. Where ample quantities of steam can be made available the steam type has been employed rather than the compression type, because the disadvantage of lower fresh water to fuel ratio is more than offset by decreased complication and maintenance.

"*Present state of development*

"Present-day successful marine distilling plants, heated by steam, vaporize the sea water in a type of evaporator that is generally described as "low-pressure, submerged tube." Low pressure means pressure below atmospheric, i. e., vacuum, and is employed because it is associated with relatively low temperatures (below 212° F.) and consequently reduced scale formation. Submerged tube means that the heating surface consists of tubes surrounded by sea water and carrying heating steam inside. Some of the salt deposited out of the sea water settles on the outside of the tubes as a scale and must be removed more or less frequently in order to permit the heat to continue flowing through the walls of the tubes.

"A more recent development is the so-called low pressure flash type in which the salt water is within the tubes instead of outside. It is heated in the tubes, without boiling, and the vapor is formed by reduction of pressure after the heated water leaves the tubes. Because of the absence of boiling, relatively little scale is formed in the tubes and this scale is much more easily removed than in the submerged tube type. The reason for mentioning this development is that this principle can be employed with no serious limitations on size or output of unit. A 10,000 gallon per day plant has been in service at sea for about 3 years with gratifying results. Preliminary studies have been made for a plant with a fresh water output of a million gallons per day (4,150 tons).

"*Application to shore installations*

"In the present state of our knowledge the principal type of installations that could be considered for producing large quantities of fresh water ashore, in coastal areas, by evaporation from sea water, are as follows:

"In combination with the generation of electric power by steam turbines. In this arrangement the steam supplied by boilers produces electrical energy by means of turbines and generators and then provides heat for the vaporizing of sea water. This is not a case of using waste heat and thereby getting the distillation for nothing. The total fuel burned to accomplish the dual purpose of electric generation and distillation is greater than the fuel that would be required for producing the electrical energy alone and the distilling plant must be charged with the difference. Roughly the most economical combination gives a fresh water to fuel ratio of 125. At $1.90 per barrel of fuel oil the fuel cost works out to 35 cents per thousand gallons or 8½ cents per ton.

"It is possible, of course, to divorce the distillation from electric power generation, and from the associated limitation of capacity, by providing a boiler plant to serve the evaporators direct. This entails the expenditure of about two-thirds more fuel, i. e., about 60 cents per thousand gallons or 15 cents per ton for the fuel cost of making the fresh water.

"A more promising solution is now under development. It involves the combination of two principles previously mentioned, namely, vapor compression and flash evaporation. These are applied in a manner that avoids the complication and maintenance associated with the present vapor compression type plants. The fresh water to fuel ratio obtainable, and the resulting fuel cost, now appears to be very nearly the same as in the first alternative described above where evaporation is accomplished in combination with the generation of electric power, i. e., about 35 cents per thousand gallons of fresh water. This solution has the very great advantage that the fresh water making capacity is completely independent of the generation of electric power.

"The approximate cost figures cited above relate only to the fuel consumed to produce the fresh water. They will not be very different whether this fuel is coal or oil. However, there are additional costs which comprise investment

charges, labor, and administration. These will vary with the type and design of plant adopted, and with regional and economic conditions. A lot of study is needed before one can predict closely the total costs for making fresh water from sea water in a particular coastal area; but enough has been done to indicate that, in many cases, this total cost will be less than $1.60 per thousand gallons (40 cents a ton), with the probability of substantial reductions upon further development. This is not as cheap as getting the water for nothing but it could very well be much cheaper than transporting it from where you can get it for nothing to where you must have it.

"*Conclusion*

"There is enough background of experience in the Navy, and more recently in merchant ships, to prove that it is entirely feasible to produce, by distillation from sea water, very large quantities of fresh water in every way suitable for all human and industrial use. It is quite likely that great improvements in processes and reductions in cost can still be made. If the national interest may require that these very large quantities be produced it is of the utmost importance that there be instituted a program of intensive development and research to improve the processes and, particularly, to reduce the fuel and other costs."

CONCLUSION

It is entirely feasible to produce by distillation from sea water very large quantities of fresh water in every way suitable for all human and industrial use. What is now required is the letting of a contract to a qualified manufacturer of distillation units, such as ourselves, so that a program of intensive development and research can be undertaken to improve the processes and develop greater economy. Our staff of engineers are fully competent to carry out such a program.

Respectfully yours,

KENNETH B. RIS, *President.*

Mr. SAYLOR. Mr. Chairman——

Mr. ENGLE. Just a minute, Mr. Saylor.

I have a communication here from Rohm & Haas Co., of Philadelphia, signed by Mr. Frederick J. Myers, in which they state their vital interest in this subject matter, and without objection the letter will be made a part of the record.

(The letter referred to is as follows:)

ROHN & HAAS CO.,
Philadelphia, Pa., March 5, 1952.

Congressman CLAIR ENGLE,
Subcommittee on Irrigation and Reclamation,
Committee on Interior and Insular Affairs,
House of Representatives, Washington, D. C.

DEAR SIR: We appreciate your courtesy in sending us a copy of H. R. 6578 which has to do with the desalinization of water.

We have recently been in touch with the Department of Interior, Bureau of Reclamation, in connection with the desalinization equipment shown to Mr. Jenkins during his visit of last July to our laboratories. More recently, we have been corresponding with Mr. Lineweaver regarding the specific information which they require from us, and are presently considering the questions which he has raised.

I note that you do not intend to have any additional testimony on this bill, nor do we have any specific comments which we would like to make at this time. We assure you, however, that we are vitally interested in this development, and hope to be in a position to undertake cooperative work with the Department of Interior in the not too distant future.

Thank you again.

Very truly yours,

FREDERICK J. MYERS.

Mr. ENGLE. We also have a communication under date of March 7 from the Secretary of the Interior, and that, without objection, will be made a part of the record.

Mr. BOW. I would like to object, Mr. Chairman.

I notice that in that letter of March 7 of the Department, reference is made of the Griscom-Russell Co., and that it refers to them as being from Nashville, Ohio.

That should be corrected. The Griscom-Russell Co. is from Massillon, Ohio.

Mr. ENGLE. With that understanding, the communication from the Secretary, without objection, is made a part of the record.

(The letter referred to is as follows:)

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., March 7, 1952.

Hon. CLAIR ENGLE,
Chairman, Subcommittee on Irrigation and Reclamation,
House of Representatives, Washington, D. C.

MY DEAR MR. ENGLE: Your letter of March 4, 1952, requested up-to-date information concerning types of research which might be undertaken in methods for converting salt water to fresh water. You also inquired specifically regarding the process being developed by Ionics, Inc., of Cambridge, Mass.

We have been in close touch with the Ionics' development which was announced by the American Research & Development Corp., of which Prof. Edwin R. Gilliland, of Massachusetts Institute of Technology, and Dr. Karl T. Compton, formerly president of that institute, are among the board of advisers. Our connection with Ionics, Inc., and with the Massachusetts Institute of Technology concerning salt-water conversion processes dates back several years. In November 1949, Interior Department engineers inspected the work being conducted at Cambridge by Ionics, Inc., and by the Massachusetts Institute of Technology on the use of solar energy for salt-water conversion, and reported that excellent, although slow, progress was being made, Early in 1950, I corresponded with Dr. James R. Killian, president of Massachusetts Institute of Technology, who assured me of the cooperation of that institute with the Government in our endeavor to develop low-cost methods of this purpose.

More recently I was delighted to receive a joint, confidential report by an engineer of the Bureau of Reclamation and one of the Geological Survey concerning this process which has been suggested by Ionics, Inc., and I was further pleased to learn subsequently from the press reports of the low costs of the fresh water which the Ionics' scientists believe may ultimately be produced by this method.

As I understand the process, its application to the separation of salt from water is relatively new, although the principle of separation by means of semipermeable membranes has been used for many other purposes. Our Bureau of Mines of this Department has for some time separated certain gases by means of semipermeable membranes.

The results of the model tests by Ionics, Inc., are indeed encouraging, but there are nevertheless many problems remaining to be solved when the principle is used for the separation of actual sea water, for improvement of brackish waters, particularly in the presence of algae or other slime-producing matters, and especially when used on the volumes needed for supplying significant quantities of municipal, irrigation, or industrial water at low costs. Although the use of electrical energy in the process is low in comparison with that required by other processes, it is still significant in relation to the eventual total cost and may become even more significant in actual operation on waters which by slimy deposits will increase the electrical resistance of the membrane and hence increase the use of energy. Another important factor not yet fully evaluated is the actual life of the membrane. Under present assumptions of that life, which controls the amortization factor of investment, about one-third of the cost of the improved water is accounted for.

Although we continually receive communications from individuals, firms, and other sources, indicating that they have already developed processes of various kinds, we have not seen working models of their process and hence cannot tell if they are actually making progress. So far as we are aware, the work by Ionics, Inc., as well as the similar work under way by various firms, indicates one of the best examples of recent progress in this field.

There are a great many people, organizations, universities, etc., working in this field. I have already mentioned the Masschusetts Institute of Technology and Ionics, Inc. To name just a few of the others, some of which are working diligently on problems related to the subject, while others work more or less sporadi-

cally in the field, there are the University of California, Berkeley; University of California, Los Angeles; University of Denver; Arthur D. Little & Co., of Boston; Griscom-Russell Co. of Massillon, Ohio; Cleaver-Brooks Co. of Milwaukee; the Industrial Processes Co. of Philadelphia; Rohm & Haas, Inc., of Philadelphia; Electricite De France, of Paris, France; the Encino Water Research Group, of Encino, Calif.; Sea Water Corp., of San Diego, Calif.; the Ocean Water Committee of San Diego, Calif.; the Atomic Research Corp., of Colorado Springs, Colo.; World Water Co., Phoenix, Ariz.; and others.

The encouragement which we have been able to give to such organizations as Ionics, Inc. and others even in the absence of financial assistance which they clearly need, has undoubtedly aided them in their calculations and encouraged them to proceed with their research in the development of the present small units. We are working closely with that organization, and with other chemical firms who have been frank to state that the job is one in which both Government and private industry should work together. Representatives of one large chemical firm have stated to our engineers that they are primarily interested in the production of chemical substances suitable for salt-water separation and possibly in the fractional separation of various elements for producing valuable chemicals, but that they are not and will not be able to extend the scope of their activities to research necessary for the production of water on a large scale. This, they have stated, is, in their opinion, a job for the Federal Government working cooperatively with industry.

The information already submitted to the Subcommittee on Irrigation in regard to the possible fields in which research could be conducted is fairly complete, and I have no detail to add to it at this time expect to state that additional work is needed on the principle used in the process described by Ionics, Inc. I visualize the program of research and development in this field to consist of a concurrent study of numerous processes, both for the improvement of existing methods, and development of those which have been merely suggested, or tried only in a small way, as well as seeking completely new approaches. The role which the Federal Government should play in this at present, and until processes are perfected up through the pilot plant stage which would justify their use in a demonstration plant is first, to assist those researchers to proceed who would not otherwise be able to pursue ideas having real merit and second, to coordinate the entire program of research and development by private institutions, industry, and Government, in such a way to assure that all possible processes are exhaustively explored and at the same time eliminate processes which are clearly proven from time to time to be infeasible.

It cannot be expected that a single firm, university, or research institution, will possess sufficient interest in all of the numerous methods which must be explored to justify investigating them exhaustively, as will be necessary before we can be assured that for money spent we are getting fresh water at the point where it is needed at the lowest possible price. Methods which have considerable merit range from various mechanical, chemical, and electrical machines to the exploration and utilization of such energy sources as the heat of the sea itself, the internal heat of the earth, that of the sun and the power of the wind. Our discussions with representatives of the Massachusetts Institute of Technology indicate that they are interested primarily in chemical processes and solar energy. At the same time others are interested in developing the energy of the sea, the sun, and the wind, for this purpose, while still others have experience in other principles.

I visualize some research under this program on isolated problems by students in numerous universities. As limited time and funds available to us for this purpose have permitted, we have been in contact with officials and heads of a number of universities with this in mind, and I am pleased to report that they have expressed welcome and approval of this approach.

In such agencies of this Department as the Bureau of Reclamation, Geological Survey, and Bureau of Mines, we have highly qualified scientists and engineers, some of whom have had full-time experience in directing Government research and development programs in the physical sciences entirely under contract by universities and private industry. Those personnel, together with our good friends in such other departments as Navy and Agriculture, upon whom we can and do call for assistance, will make it unnecessary to build a large additional organization to handle this program effectively. I believe sincerely that we have a real opportunity here for a program in which universities, private industry, and private research institutions, properly coordinated by a staff of qualified Federal scientists, will demonstrate that it is possible to produce meritorious scientific results eco-

nomically and without monopoly either by Government or by any individual private corporation.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

Mr. ENGLE. Mr. Saylor?

Mr. SAYLOR. Mr. Chairman, I think for the benefit of the members of the committee, paragraph 3 on page 2 of the letter which has been just now introduced should be read, so that the members of the committee will all have first-hand knowledge of it, in view of what is to come—first-hand knowledge of the institutions and organizations that are already working in this field.

Mr. ENGLE. You say you are referring to paragraph 3 on page 2?

Mr. SAYLOR. To the paragraph beginning: "There are a great many people, organizations, universities, et cetera, working in this field."

Mr. ENGLE. Will you go ahead and read it, Mr. Saylor.

Mr. CRAWFORD. Just a moment. Will you yield?

Mr. SAYLOR. Yes.

Mr. CRAWFORD. What is it that you are now reading from?

Mr. SAYLOR. I am reading from page 2, paragraph 3, of a letter dated March 7, 1952, from Oscar L. Chapman, Secretary of the Interior, addressed to the Honorable Clair Engle, chairman of the Subcommittee on Irrigation and Reclamation.

Mr. CRAWFORD. That is a report on what bill?

Mr. SAYLOR. That is not a report on any bill. It is a letter directed by the Secretary of the Interior to Mr. Engle, giving up-to-date information pertaining to the types of research which have been undertaken with regard to H. R. 6578.

The paragraph on page 2, to which I refer, the members of the committee might not have seen. It states:

> There are a great many people, organizations, universities, et cetera, working in this field. I have already mentioned the Massachusetts Institute of Technology and Ionics, Inc. To name just a few of the others, some of which are working diligently on problems related to the subject, while others work more or less sporadically in the field, there are: The University of California, Berkely; University of California, Los Angeles; University of Denver; Arthur D. Little & Co. of Boston; Griscom-Russell Co. of Massillon, Ohio, Cleaver-Brooks Co. of Milwaukee; the Industrial Processes Co. of Philadelphia; Rohm & Haas, Inc., of Philadelphia; Electricite de France of Paris, France; the Encino Water Research Group of Encio, Calif.; Sea Water Corp. of San Diego, Calif.; the Ocean Water Committee of San Diego, Calif.; the Atomic Research Corp. of Colorado Springs, Colo.; World Water Co., Phoenix, Ariz.; and others.

Mr. D'EWART. Will you yield.

Mr. SAYLOR. I would be happy to yield.

Mr. D'EWART. In addition to those cited, I am informed also the Research Institute, Stanford, Calif.; Purdue University, Rickings Polytechnic Institute, University of California, both branches, Southwest Research Institute of San Antonio, are all engaged in research related to this project. I am further informed that the Conservation Foundation of New York has a grant for a survey of past work in this field.

Further, I have here and in my hand, a letter addressed to John R. Murdock, signed by E. R. Gilliland, president of Ionics, Inc., and enclosing a bulletin entitled:

"New Frontiers in Solution Chemistry—Permionic Membrane Demineralization; Bulletin No. 2; February 1952."

I would like to have that made a part of the record, together with the correspondence between Mr. Murdock and this agency.

Mr. ENGLE. Without objection, it will be so ordered.

(Bulletin and correspondence referred to are as follows:)

IONICS, INC.,
Cambridge 42, Mass., February 28, 1952.

Hon. JOHN R. MURDOCK,
House of Representatives, Washington, D. C.

MY DEAR MR. MURDOCK: We appreciate your interest in writing to us and in informing us of the legislation proposed by Mr. Engle. As you requested we are giving you additional information concerning our new demineralization development and its possible application to the large-scale purification of brackish and sea water.

Ionics has now demonstrated a small working model of a demineralization unit based on a scientific principle which has not hitherto been commercially applied to the desalting of water. As reported in the papers and in the enclosed bulletin (which is our official draft of the publicity release), the new development utilizes electrical power in conjunction with new synthetic membranes which have been developed by Ionics and are now marketed under the trade-mark Permionic.

In the next year it is important that we spend our time in the development and testing of relatively small units, for example, in the range of 50 to several hundred gallons per hour. As in any new technical development, a considerable amount of engineering effort will be required to solve the problems connected with the design and commercial production of such units. Once the problems of building moderate-size units have been solved, we intend to proceed to the problems of the design, production, and construction of large plants such as might be suitable for municipal and agricultural use.

To design and engineer the large units simultaneously with the moderate-size unit would involve duplication to an extent we believe to be undesirable. The development of large-scale plants might be expedited by such duplication; however, it is clear that such a program would involve greater technical and financial risks.

Among the problems which must be investigated before the process can be regarded as definitely established for the low-cost, large-scale fields are those concerning the life of the membranes under constant use; the necessary pre- and post-treatment of the water, if any; periodic maintenance of the unit, including cleaning if natural growths are found to occur; the optimum size of individual components; and the development of large-scale production facilities for components.

The power costs which have been quoted in the enclosed release we consider to be reasonably firm. They represent direct measurements which have been made in our laboratories on operating units having an output of several gallons per hour and on membranes which have been shown to have a life of at least several months. We must point out that the estimates of the cost of producing large units, and therefore of the amortization charges, are necessarily less firm, because they are based on extrapolations of the data obtained on the small units.

With respect to amortization and maintenance costs, it should be mentioned that (1) the components of the present units use basically inexpensive raw materials, (2) a large-scale unit would be composed of a multitude of similar components which would therefore be amenable to mass production, and (3) there is no basic chemical reason that would lead one to expect a deterioration of the membranes with use.

In order to protect our position, Ionics does not wish to make public the details of operation, construction, or formulation at this time. We would, of course, be pleased to cooperate with the committee insofar as we can do so without jeopardizing our commercial or technological position.

We will be glad to receive any specific questions you may have. If you or your associates should be in Boston, we would be pleased to discuss the matter with you further and to demonstrate the operating model of the process which we have prepared.

I want to emphasize that the Massachusetts Institute of Technology was not involved in this development. All of the work has been done by Ionics, Inc.

We have also received a letter from Mr. Clair Engle, Member of Congress, and we are sending him similar information.

Yours very truly,

IONICS, INC.,
E. R. GILLILAND, *President.*

HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERIOR AND INSULAR AFFAIRS,
Washington, D. C., February 23, 1952.

Prof. EDWIN R. GILLILAND,
Department of Chemical Engineering,
Massachusetts Institute of Technology, Cambridge, Mass.

DEAR PROFESSOR GILLILAND: I read with much interest the article of February 20 in the New York Times reporting a revolutionary new process for desalting sea water. This subject is now before the Committee on Interior and Insular Affairs as a result of legislation introduced by Representative Clair Engle of California. Previously the Subcommittee on Irrigation and Reclamation considered bills on this subject introduced by Representatives McKinnon and Phillips of California.

The article was of particular interest to me when it mentioned the probable low cost of improving brackish waters. This, as you may readily imagine, is something that holds great promise for the southwestern part of Arizona in Maricopa and Yuma Counties.

I would appreciate it very much if you would send me any additional information that might be available concerning the process reported on in the newspaper.

Sincerely yours,

JOHN R. MURDOCK, M. C.,
Chairman.

NEW FRONTIERS IN SOLUTION CHEMISTRY—PERMIONIC MEMBRANE DEMINERALIZATION

IONICS, INC.

Ionics, Inc. was founded in December 1948, by American Research and Development Corp. (ARDC) of Boston, the venture capital investment company formed by a coalition of investment trustees, educational institutions, insurance companies, forward-looking businessmen, and scientists of Massachusetts Institute of Technology.

In 1948, Dr. Walter Juda, vice president and technical director of Ionics, Inc., (then an instructor at Harvard University) was acting as a consultant in chemistry to ARDC. Several of the ARDC officers and advisers, impressed with Dr. Juda's picture of the important role which ion exchange and ion transfer membranes might play in industry, decided to establish Ionics, Inc., to do consulting, research, and process development.

The company has assembled and trained an outstanding team of chemists and chemical engineers, constituting one of the largest ion-exchange groups in the country and one of the few devoting major effort to process design, process development, and application research. In the 3 years of its existence, Ionics, Inc. has solved long-range problems of purification and recovery for several Government agencies and large industrial firms, while, at the same time, it has developed from the earliest stage the new synthetic membranes and equipment for their use. The company has maintained an active independent development program in a wide range of fields including treatment of brackish waters for community and industrial purposes, separation of rare elements, preparation of valuable pharmaceuticals and large-scale production of certain heavy chemicals. Ionics, Inc. has a continuing program of research on membranes and membrane uses and further important processes are under development. The Permionic membrane demineralization process and other important developments of Ionics, Inc. are now ready to make their contribution to the progress of industry and the expansion of agriculture.

LOW COST DEMINERALIZATION OF SEA WATER MADE POSSIBLE BY PERMIONIC MEMBRANES

A method for the demineralization of sea water, based on the use of electrical energy in conjunction with new synthetic membranes, has been announced and demonstrated to representatives of press, Government, and industry by Ionics, Inc., a research and development company of Cambridge, Mass. Cost of the process is one-half to one-third of that required by the most economical process now commercially available, the vapor compression evaporator. Coming at a time when the expansion of vital industries, agriculture, and urban populations is severely limited by lack of fresh-water supplies in important areas of New York, Texas, California, and many other States of the far West, the method is expected

to be able to provide relief in key areas in a relatively short time, and holds out the long-range promise of opening arid lands in the United States, Australia, Israel, and the Middle East to settlement and cultivation.

At the heart of the method are new synthetic membranes marketed by Ionics, Inc., for several years, under the trademark "Permionic." A stream of sea water fed to a unit using the membranes emerges after treatment, split into two streams—one a fresh-water stream, two-third of the volume of the feed and containing practically none of the salt; the other a brine stream, one-third the volume of the feed and containing all of the salt. The fresh water produced can be used for drinking, industrial, or agricultural purposes. The brine must be disposed of, but may first be further treated to produce salt, magnesium, or other chemicals derived from sea water. The energy required for the process is furnished in the form of electrical power. The flows are continuous and the apparatus has no moving parts other than the water stream. Water pumping costs are negligible. The process uses no heat or chemicals. A membrane unit of a given size will purify sea water over a wide range of flow rates if the amount of electrical power is increased as the sea-water flow is increased. However, the faster the flow, the more expensive the fresh-water production becomes in terms of electrical energy used per gallon. At relatively low flow rates, energy consumption can be as low as 20 kilowatt-hours per thousand gallons. The best commercially available performance for other processes is obtained from so-called vapor compression evaporation in which approximately 100 kilowatt-hours per thousand gallons is required. In many areas of the West where the water problem is acute, electrical energy is available for as little as 3 mills per kilowatt-hour. Therefore, the Permionic membranes make possible production of fresh water from the sea in such areas for a power cost of only 6 cents per thousand gallons. The cost of the equipment must be added to this figure. By comparison, industrial water supplies from fresh-water sources may cost up to 10 cents or more per thousand gallons and residential supplies 20 to 30 cents (owing to the cost of water distribution mains). Irrigation water is sold in the West for from 2 to 20 cents per thousand gallons.

Because low power costs in Permionic membrane demineralization are achieved at low output levels and the equipment cost must be added to determine the true cost, the long-range success of this method of purifying sea water has been dependent on cheap mass production of suitable membranes of long useful life. These membranes are continuous films of synthetic plastic materials usually 10 to 40 thousandths of an inch thick. They are made largely of cheap coal-tar and petroleum chemicals and are amenable to continuous production owing to their sheet-like character. The membranes and equipment will be mass produced at sufficiently low cost so that the total cost of sea-water purification with cheap power can be brought to the range of 10 to 20 cents per thousand gallons.

Even more attractive than the purification of sea water with Permionic membranes is the purification of brackish water. Water is brackish when it has been contaminated with moderate salt concentrations (one-tenth to one-fifth that of sea water) by intrusion of sea water or oil well brines into fresh well water, or by percolation of fresh water through rocks and soils containing soluble minerals. For brackish waters, now widely found in the Western States, Bermuda, the Hawaiian Islands, the Bahamas, and Cuba, and in many desert areas of Asia, Africa, and the Middle East, the new process is markedly cheaper than from sea water. By use of the new membranes, the electrical energy consumed in purification of many common brackish waters may be as little as one cent per thousand gallons. Such costs are very attractive, even for irrigation water where permissible costs are quite low. In contrast, the vapor compression evaporator using cheap power requires about 35 cents of electrical energy to purify a thousand gallons of brackish water.

This outstanding economy is made possible by the difference between the basic principle of membrane demineralization and that of conventional purification by evaporation. In evaporation, the water is vaporized, the salt is left behind, and the water vapor is condensed to pure water on a cool surface. In essence, the water is removed from the salt. It is therefore as expensive to purify brackish water by this method as it is to purify sea water.

By contrast, with Permionic membrane demineralization, the salt is removed from the water by electrical energy, and the cost of removal becomes cheaper per gallon of water as the salinity of the raw water is reduced. The cost advantage of the membrane process over evaporation for brackish waters can be as great as one hundredfold.

In addition to its use in the purification of natural waters, Permionic membranes are attractive for many industrial applications—purification of sugar, glycerine, milk, and organic products, and recovery of valuable chemicals and metals from waste streams.

Many of these tasks can now be performed by a chemical process, ion exchange. Ion exchange is at present carried out in towers packed with coarse sand-like granules of ion-exchange resins through which the liquids to be treated are percolated. Most ion-exchange processes require intermittent batch operation since treatment must be frequently stopped to wash the beds and to refresh them with strong, corrosive chemicals such as sulfuric acid and caustic soda. Permionic membranes make possible continuous performance of such jobs without necessity of buying or handling chemicals, in much smaller and simpler equipment, and for one-half to one-tenth the cost. They are, therefore, expected to find wide application in the industrial, chemical, and waste disposal fields.

Permionic membrane demineralization makes possible, for the first time, continuous economical desalting of sea water, brackish water, and industrial solutions.

PERMIONIC MEMBRANES—A NEW TOOL FOR SOLUTION PROCESSING

Ion-selective membranes play a dominating role in living organisms. A great many attempts have been made to prepare such membranes of mechanical strength sufficient to permit their use in industry. A solution of this important and crucial problem has now been achieved by Permionic membranes.

The production of Permioni ion transfer membranes in continuous sheets of good mechanical stability made possible the exploitation of a unique combination of properties including high ion-selectivity, high electrolytic conductance, and high hydraulic resistance.

In figure 1 there is shown a simplified molecular model of a Permionic membrane. The basic structure of the membrane is a cross-linked skelton of polymeric material which has been described as a three-dimensional fish net. In the interstices of this network there is water. At various places in the network there are active charged spots bound into the structure. In an anion membrane these spots carry a positive charge; in a cation membrane, such as the one pictured, these spots are negative.

Each active spot is countered by an ion of the opposite sign which is more or less mobile and is dissolved in the water of the membrane. If a Permionic cation membrane is placed in a solution of a salt, there will be interchange of positive ions between the solution and the membrane. However, the negative charges in the membrane cannot move and, at all times, there will be a number of positive ions held in the structure equal to the number of bound negative charges.

A membrane is said to be ion-selective when it exhibits preferential transfer for ions of a given sign. A cation membrane shows high ion-selectivity for positive ions (cations). The ion-selectivity of a membrane for cations is due to the fact that the number of positive ions inside the membrane is always greater than the number of mobile negative ions.

The discovery of Permionic ion transfer membranes and the first preparation of the materials is credited to Walter Juda, vice president and technical director of Ionics, Inc., and Wayne A. McRae, supervisor of the patent department of Ionics, Inc.

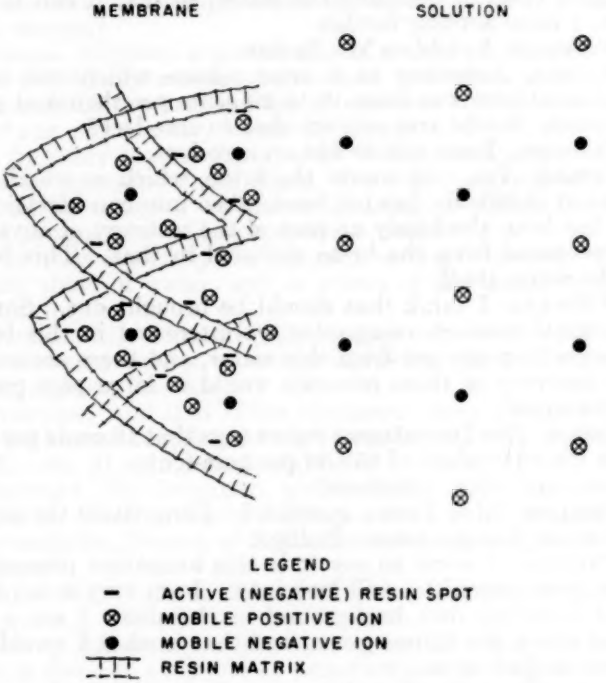
One of the most important long range aspects of the development of Permionic membranes is their use in basic biological and medical research. Because the body contains hundreds of different ion-selective membranes of various functions, including those in the kidney, the nerves, the lungs, the blood vessels, and the intestinal tract, biologists have for a long time been interested in membrane science and many of the advances in understanding the field have come from their efforts. However, medical researchers have always been hampered by the difficulty of isolating the body membranes and making measurements outside the living organism. These difficulties have led to attempts to measure basic membrane properties on synthetic membranes. The general principles of membrane behavior so obtained are then applied to studies of the life processes. However, such attempts have been hampered by the difficulty in preparing such membranes and by their fragility and lack of reproductibility.

The preparation by Ionics, Inc., of synthetic membranes which are strong enough to be easily handled in any size, which are simple enough in structure for easy and reproducible characterization, and which are readily available, has therefore been of considerable interest to the biological and medical profession.

Mr. D'EWART. Mr. Chairman, I would like to read into the record one or two sentences from this Permionic membrane demineralization report, which show the progress they are making in the experimental work which they are doing—and which I think is progress that will perhaps reach down to where it will be helpful to irrigation, and municipal water use:

By use of the new membranes, the electrical energy consumed in the purification of many common brackish waters may be as little as 1 cent per thousand

FIGURE 1
SIMPLIFIED MOLECULAR MODEL OF A PERMIONIC CATION MEMBRANE IN SOLUTION



gallons. Such costs are very attractive, even for irrigation water where permissible costs are quite low. In contrast, the vapor-compression evaporator using cheap power requires about 35 cents of electrical energy to purify a thousand gallons of brackish water.

I think that illustrates, in very short, sharp sentences, the progress that has been made by one of the principal research laboratories.

The point I make is that this research is being undertaken, as indicated by Mr. Saylor and myself, by a number of universities, and they are making real progress toward the solution of the problem of the purification of alkaline and other salted waters, and that is progress which can be of great benefit for irrigation and domestic use in all parts of the country.

Mr. MILLER. Will the gentleman yield?

Mr. D'EWART. Yes.

Mr. MILLER. Do you understand that they are able to take the salt out of sea water at a cost of 1 cent per thousand gallons?

Mr. D'EWART. That is the cost of the electrical energy, 1 cent per thousand gallons.

Mr. MILLER. And they will take the salt out of sea water?

Mr. D'EWART. Brackish water—and that would include sea water.

Mr. Bentsen. What are the other costs?

Mr. D'EWART. Plant costs, for one thing.

Mr. ENGLE. Just one moment. Mr. D'Ewart has the floor.

Mr. D'Ewart, the gentleman from Texas is asking you to yield—if you are through, Mr. Miller?

Mr. MILLER. Well, unless there is something in there which shows the complete costs of desalting the water, so that it can be used for irrigation, I have nothing further.

Mr. D'EWART. I yield to Mr. Saylor.

Mr. SAYLOR. According to a press release which was made last week, the total cost was from 10 to 20 cents per thousand gallons.

Mr. ENGLE. Would you convert that to acre-feet?

Mr. BENTSEN. From $32 to $64 an acre-foot.

Mr. SAYLOR. Yes. Of course the brine, which as we all know, is the source of chemicals, has not been taken into consideration.

There has been absolutely no part of the recovery of anything that can be recovered from the brine included in that. This is just the cost of the water itself.

Mr. D'EWART. I think that should be brought out. Some of the large chemical research companies are interested in this because of the minerals they can get from this water, and there are some hopes that the recovery of these minerals would in large part pay for the cost of the water.

Mr. ENGLE. The Department report says that 10 cents per thousand gallons is the equivalent of $32.50 per acre-foot.

Are there any other questions?

Mr. PHILLIPS. May I ask a question? I am not on the committee?

Mr. ENGLE. Comgressman Phillips.

Mr. PHILLIPS. I want to say it is this ionization process which I hope that your committee will look into. I am very much interested in it and from my own background in chemistry I am a little bit concerned about the figures given, and that is what I would ask your committee to look into.

The figure given was 5 cents at one time, and the 1 cent in your letter, Wes, is, of course, for the cost of the power, the energy, and not for any other incidental cost, for example, that of pumping the water, and so forth.

But more than that, this process involves a series of membranes—and the doctor will understand it very well. Now, they have taken these experiments not with sea water, but with prepared water, taking clear water and putting salt in, which is very different from trying to pump or put through by the ionization process the sea water through a long series of membranes.

I am not in any way critical of it but it is a very excellent point, a very fine possibility; but at this time it is a laboratory process, while some of the other processes are developing in experiments using actual sea water, and I hope that you will go into that thoroughly in your committee investigation and get the answers to all these questions

which I think are there. In fact, I know you will do that in your committee investigations.

Mr. ENGLE. There is a good deal of difference taking brine water, which is pure water mixed with salt, and taking ordinary sea water.

Mr. PHILLIPS. And particularly in the laboratory.

Mr. ENGLE. There is one other thing that concerns me with the ionic process. The report seems to indicate the cost goes up as the volume increases, instead of the reverse. Ordinarily the larger the volume, the lower the per unit cost. But as I read what they had to say, it appeared to me that the per unit cost went up with the volume—which was rather unusual. I could not understand that.

Mr. PHILLIPS. Is that the cost of cleaning the whole series of hundreds of membranes through which the water has to sift through the electrical process?

Mr. ENGLE. Without a doubt this is a field which has an opportunity to practically revolutionize water problems, not only in the United States, in the arid regions of our own country, and in other regions of our own country where we are short of water, which is the situation in many metropolitan areas, but in addition, revolutionize the situation throughout the world, if a cost for purification of this water could be achieved which would bring it within the economic bounds of commercial and metropolitan usage.

I have in mind especially the situation in San Diego, where they are desperately short of water, and in others of the costal metropolitan areas in California.

Mr. MILLER. Mr. Chairman, if the cost is to be $34 for irrigation purposes, it would have to be a very highly specialized crop to justify that much expense for water.

Mr. BENTSEN. And that is the minimum; they stated it was 10 to 20 cents per thousand gallons—which would run it up to $65.

Mr. MILLER. It would be prohibitive.

Mr. BENTSEN. For irrigation, pretty well.

Mr. ENGLE. Well, in Santa Barbara, we have an area with a contract now with the Bureau of Reclamation which is either $30 or $35.

Mr. CARR?

Mr. CARR. It is $35 for municipal water and $25 for agricultural water.

Mr. ENGLE. But in any event, for metropolitan and industrial uses, if you got it down to even $35 an acre-foot you could get down to the point where on an exchange basis, water say for San Diego could be used very differently. The water which is currently brought in from the outside great distances could be used on the outside, and the water such as this used for the metropolitan and industrial uses of the city. It represents a tremendous opportunity.

Now, do we have the material in the record that we want in the record?

Mr. MORRIS. Mr. Chairman, there is just one thing. I don't know whether you or the other members have this but I have in my files a very important statement recently made by the Massachusetts Institute of Technology in regard to the sweetening of saline water. They have made a very important statement and I ask permission at this time to insert in the record at this point that statement which I have in my files. I don't know whether some one else has put it in the record or not, to my knowledge.

Mr. ENGLE. That is the matter which Mr. D'Ewart inserted in the record by Ionics, Inc., which is not a part of the Massachusetts Institute of Technology but which has some of its personnel working with Ionics.

Mr. D'EWART. I believe a professor from MIT is heading up the work.

Mr. MORRIS. In that case——

Mr. ENGLE. The press release would still be interesting as part of the record, especially the press release which appeared in the New York Times, or the equivalent, and we would be glad to have it.

Mr. MORRIS. With your permission, I will get it from my files.

Mr. ENGLE. And you may insert it at this point in the record.

(The press release referred to reads as follows:)

[From New York Times, Thursday, February 21, 1952]

NEW PROCESS DESALTS SEA WATER; PROMISES VAST HELP TO ARID AREAS

(By William Laurence)

BOSTON, February 20.—A revolutionary new process for desalting sea water, promising to open vast new reservoirs of fresh water for use in agriculture, industry, and the home wherever water is now scarce, was demonstrated here today at the national meeting of the American Research & Development Corp.

The process is based on the use of electrical energy in conjunction with new synthetic membranes that, according to scientists, makes possible for the first time the continuous economical desalting of sea water, brackish water, and industrial solutions.

The membranes do their work by a chemical process known as ion exchange, in which positive and negative electrical charges are interchanged, leading to the separation of certain minerals and salts according to the electrical charges they carry.

A stream of sea water fed to a unit using the membranes emerges split into two streams—a fresh-water stream, two-thirds of the volume of the feed and containing practically none of the salt, and a brine stream, one-third the volume of the feed and containing all the salt.

The fresh water may be used for drinking or for industrial or agricultural purposes. The brine may be further treated to yield salt, magnesium, or other chemicals derived from sea water.

Announcement of the new process was made by Prof. Edwin R. Gilliland, of the department of chemical engineering at the Massachusetts Institute of Technology, and president of Ionics, Inc., of Cambridge, Mass., an affiliate of the American Research & Development Corp.

Dr. Karl T. Compton, former president of MIT and a member of the board of advisers of the development corporation, hailed the new process as offering great promise in many fields of application.

Dr. Arthur B. Lamb, professor emeritus of chemistry at Harvard, now a director of the Ionics Co., said the process opened a new era in the desalting of sea water with much greater economy than by other methods.

The process was developed by a group headed by Dr. Walter Juda, vice president and technical director of Ionics. Dr. Juda is research associate at the Harvard Medical School and a consultant at the Oak Ridge National Laboratory.

The new process comes at a time when the expansion of vital industries, agriculture, and urban populations is limited by the lack of fresh-water supplies in important areas of New York and Texas and States of the Far West, including California. It is expected to provide relief to key areas in a relatively short time and it holds out the long-range promise of opening up arid lands in the United States, Australia ,and the Middle East and other parts of the world for settlement and cultivation.

ELECTRICAL POWER IS USED

The energy required for the process is furnished in the form of electrical power. The flows are continuous and the apparatus has no moving parts other than the water stream. The process uses no heat or chemicals.

A membrane unit of a given size, it was pointed out, "will purify sea water over a wide range of flow rates if the amount of electrical power is increased as the sea-water flow is increased."

"However," it was added, "the faster the flow the more expensive the fresh-water production becomes in terms of electrical energy used per gallon.

"At relatively low-flow rates energy consumption can be as low as 20 kilowatt-hours per 1,000 gallons. In many areas of the West, where the water problem is acute, electrical energy is available for as little as 3 mills per kilowatt-hour. Therefore the membranes make possible production of fresh water from the sea in such areas for a power cost of only 6 cents per 1,000 gallons, to which must be added the cost of the equipment.

"By comparison, industrial water supplies from fresh-water sources may cost up to 10 cents or more per 1,000 gallons. Irrigation water is sold in the West for from 2 to 20 cents per 1,000 gallons."

The membranes are continuous films of synthetic plastic materials, usually from ten- to forty-thousandths of an inch thick. They are made largely of cheap coal-tar and petroleum chemicals and are said to be "amenable to continuous production owing to their sheetlike character."

"The membranes and equpment," it was announced, "will be mass-produced at sufficiently low cost so that the total cost of seawater purification with cheap power can be brought to the range of 10 to 20 cents per 1,000 gallons."

By the use of the new membranes, it was stated at the demonstration, "the electrical energy consumed in the purification of many common brackish waters may be as little as 1 cent per 1,000 gallons."

In addition to its use in the purification of natural waters, the membranes promise to find wide uses in many industrial applications, such as the purification of sugar, glycerine, milk, and organic products and the recovery of valuable chemicals and metals from waste streams.

One of the most important long-range aspects of the development of ion-exchange membranes is their potential use in biological and medical research. The body contains hundreds of different ion-selective membranes of various functions, including those in the kidney, the nerves, the lungs, the blood vessels, and the intestinal tract. The synthetic membranes may serve as media for studying the behavior and properties of these membranes in the living body and thus shed light on some of life's most fundamental mechanisms.

Mr. ENGLE. With that out of the way, without objection, H. R. 6578 will be considered as read for amendment.

Mr. BOW. I would like to offer a substitute for this bill, Mr. Chairman.

Mr. ENGLE. Let us get the bill read for amendment.

Without objection, the bill will be considered read for amendment.

If there are no amendments, the substitute bill offered by the gentleman from Ohio, Mr. Bow, will be considered.

So ordered.

Mr. BOW. I would like to offer it now.

Mr. ENGLE. Would you describe what the substitute does?

Mr. BOW. I handed a copy to the clerk. It amends the title of the act to provide for correlation and coordination of research into practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

Page 1 remains the same.

Page 2 remains the same down to line 3, the word "authorized," and then the balance of lines 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12, 13 and 14, are stricken.

In other words, I have stricken the demonstration plant and it is stricken clear down to line 21.

Then I add a substitute for paragraph (a), this provision:

(a) To supervise and direct the coordination and correlation of research and development work, which shall be limited to that work directly necessary to the

development of one or more practicable processes, to ascertain the lowest investment and operation costs and to determine the best plant designs and conditions of operation.

And then (b) is amended by striking out "to engage, by contract," on line 21, and to read:

To engage, by contract, for the purposes outlined in subsection (a)—

and then, from the language in the bill—

chemists, physicists, engineers, and other such personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work—

which brings us to the first line of page 3, and then on page 3, strike lines 1, 2, 3, 4, 5, and 6, and substitute this language:

To correlate and coordinate, to the extent appropriate, the research and development work in this field being made by such educational institutions, scientific organizations, or industrial or engineering firms.

Then lines 7 and 8 on page 3 remain the same, and then we strike lines 9, 10, 11, 12, 13, 14, and 15 inclusive, and add this language:

(c) To acquire, by purchase, license, lease, or donation, technical data, inventions, patent applications, patents and licenses, to be made available to such chemists, physicists, engineers, educational institution, scientific organization or industrial or engineering firm engaged in any part of the research or other work:

And then the bill remains the same, over to line 3 on page 5, and I have stricken the "$20,000,000" and put in there in the sum, not to exceed $50,000, as Congress may direct.

Mr. ENGLE. As I understand it, your bill which you offer as a substitute does, in effect, strike out the authority of the Secretary to operate a pilot plant?

Mr. BOW. To construct or operate—and gives him authority to coordinate and correlate the activities of these various groups throughout the country that have been carrying on the research work; and he reports back to the Congress.

Mr. ENGLE. There is also opportunity to develop through this research and if we need a pilot or demonstration plant, we can always build it. It seems to me this bill carries on until such time that the report is made to the Congress.

Mr. SAYLOR. Will the gentleman yield?

Mr. BOW. I yield.

Mr. SAYLOR. I collaborated with Mr. Bow in preparing this substitute. The reason we are offering this substitute is there has been no testimony on this bill or any of the other hearings on previous bills which has come to my attention, wherein the Secretary of the Interior or anyone operating through or under him could do anything that is not already being done by other institutions who have technical experts working on this problem.

However, since there are many agencies involved, working on this, as has been called to the committee's attention by the paragraph which I read from the Secretary's letter addressed to our chairman, and also the additions to the list which were given by the gentleman from Montana, Mr. D'Ewart, it is the feeling of Mr. Bow and myself that there should be one place where all of the data that has been prepared and is being discovered from time to time should be correlated and coordinated.

For that reason we have offered this substitute which will place under the Secretary of the Interior the authority to hire an expert or two who will be in a position to gather from all of the other institutions, and to make available, not only to Congress but to all of the other institutions that are working on this problem, data, so that there will be a minimum of duplication; and if any one of the outfits that are working on it should suddenly find that somebody else has tried the same thing, they would be in a position to eliminate a number of steps.

Mr. ENGLE. When the bill was originally introduced, it was for rather broad authorization for the Interior Department to go into the field of research and to correlate research—you have got research independently; and to operate a demonstration plant.

As the bill was rewritten and reintroduced at the direction of the subcommittee, it takes out the power of the Interior Department to do independent research.

The purpose in taking out that power was because it was felt that research done independently by the Interior Department would involve a duplication of effort, would involve either the training of new experts in this same field, or the hiring of experts already employed and trained and skilled in that field, now working for educational institutions or private concerns of one kind or another.

In order to avoid any pyramiding of technical skills in the field of research, we eliminated the authority of the Secretary of the Interior to conduct independent research. The committee felt to have an overlying group of research experts who would either have to be trained separately or would have to be taken from the institutions, educational institutions and private concerns now in the field, would be an unnecessary duplication of effort.

The bill did provide, and does now provide, the Secretary of Interior does have the power to contract with various private and public institutions to proceed with various phases of research.

Now, I take it Mr. Bow, that your substitute does not eliminate that contractual feature?

Mr. BOW. The contractual feature is not eliminated, Mr. Chairman. What I have done is to strike the demonstration plant and the authority of the Secretary to conduct development work through the demonstration plant.

I think the bill is premature and that the art is not developed to the point where we should spend large sums of money for the early operation of a pilot plant.

Mr. SAYLOR. Yes; there is nothing in the bill that is offered as a substitute which would prevent the Secretary, once there has been a system evolved by those now working on it, to come before Congress and ask that we then authorize the construction of a demonstration or research plant.

Mr. BOW. Will the gentleman permit me to say further there is no method at the time being which is preferred; and if we were to build a demonstration plant we would have to pick out one or the other.

It seems to me we would run into difficulties working out the very phases being considered in this kind of work at this time.

Mr. ENGLE. Of course this is the proposition: That where private institutions having the facilities have gone into this field, they are

either protecting what they are doing by patent or by secrecy, and if they expect to make a commercial operation out of it they are not going to turn over the results of their research to the Government for general use.

They are going to try to hang onto the secrets of this process, for commercialization.

I notice in the brochure provided us by Ionics, Inc., they were careful to state they were not in a position now to reveal some of the details of the process because they wanted to protect their rights in the process until such time as they could take advantage of the process commercially, if it should be commercially usable.

So the field does present some difficulties.

Now, I am wondering, are we maintaining the incentive in the measure for private concerns to go forward. I don't know how close we are to the place where a demonstration plant ought to be operated on a large scale, and I don't know whether private agencies or private concerns would have capital or be willing to risk the capital necessary to run a pilot plant operation.

The basic issue, I take it, of the bill before the committee in the form of H. R. 6578, and before the committee in the form of a substitute offered by Mr. Bow, is whether or not the committee desires now to authorize the Secretary of the Interior to operate a demonstration plant, should he decide present research has gone far enough to warrant the operation of a demonstration plant.

Mr. BENTSEN. Will the gentleman yield?

Mr. ENGLE. Yes.

Mr. BENTSEN. The basis of my own thinking is that is the only basic issue involved.

I notice here you give the right to engage by contract some chemists, physicists, and engineers, and there is provision for appropriation of some twenty million dollars.

In Mr. Bow's bill it is cut down to $50,000.

However, in Mr. Bow's bill there is still the right to engage by contract chemists, physicists and engineers for research purposes—or just for coordination?

Mr. BOW. You can hire physicists, chemists, and engineers under my bill.

Mr. BENTSEN. For research?

Mr. BOW. Yes.

Mr. BENTSEN. To the extent of $50,000.

I think there is difficulty there, something that has to be considered and it is not just the question of the pilot plant. It is the feasibility of the pilot plant at this time, when so many different processes are being developed and put forward; and I think that is a good point that has been brought out. But I certainly think $50,000 limits any help that might be given to any of these institutions, MIT or the rest of them, that are interested in research work.

I think that is another basic difference. To have $20,000,000 in there may be too much; but $50,000 may be extremely limited, too.

Mr. ENGLE. What you say, Mr. Bentsen, is that so far as those provisions of the bill may remain in, giving power to contract, the amount limits it.

Mr. BENTSEN. The amount limits it, because just handling the administrative work would take up probably a substantial portion of the employees needed.

So I think you have in addition to that, that basic difference to consider, when working on the substitute bill which has been offered.

Mr. ENGLE. I don't know how the rest of you feel about it but the Chair would like to find out how close the Interior Department thinks it is to the point where a practical demonstration plant should be authorized.

Mr. MILLER. Mr. Chairman, I would point out the Senate cut down the original amount from $20,000,000 to $2,000,000.

Mr. ENGLE. That is correct.

Mr. MILLER. And that would not be sufficient for the pilot plant.

Mr. ENGLE. No, but it would be more adequate for contracting for more research, if that is necessary.

The Senate bill was voted out of the Senate committee on January 22, and, Mr. Carr, could you tell us what the Senate bill is?

Mr. CARR. The Senate bill is very similar to H. R. 6, except that Senate bill No. 5 had in it the research on artificial precipitation—and that was stricken completely.

The wording of the Senate bill, as amended, is very similar to the original bills, H. R. 7, introduced by Mr. McKinnon, and H. R. 6, introduced by Mr. Phillips.

The big difference in the Senate bill was the reduction of the amount of money from $25,000,000 to $2,000.000.

The wording in H. R. 6578 is much more restrictive, I believe, than the wording in the Senate bill.

Mr. ENGLE. In other words, what the Senate did was to strike out artificial precipitation and reduce the authorization from $20,000,000 to $2,000,000.

The bill we introduced according to the instructions of the subcommittee struck out the power to go into research which was continued in the Senate bill and which we limit here to the authority of the Secretary of the Interior to contract for such research; and included the right to run a demonstration plant.

Mr. Bennett, I note, is here from the Interior Department.

Mr. Bennett, would you care to make a brief statement as to whether or not it appears that we are now close enough to the point where a demonstration plant would be feasible or of any use to make it worth while to include in this legislation?

And please state your full name and position for the record.

Mr. BENNETT. N. B. Bennett, Bureau of Reclamation, Assistant Director of the Division of Project Planning.

I give you only my own opinion that we are two or three or more years away from the point where you could firmly say we need a demonstration plant for a particular purpose.

I believe Mr. Bentsen brought out, and I believe Mr. Saylor brought out, very clearly, that there are many, many methods which are in the embryo stage.

From those methods some one or some agency must select eventually one or two or possibly three of those methods which appear to have the best chance for success. And around those methods they must then construct a demonstration plant or plants, as the case may be.

Mr. SAYLOR. Mr. Bennett, do you not feel the Department of the Interior should have the benefit of some one gathering from every available source at the present time all of the available information

and to correlate it and coordinate it so that when the time comes that one or two of the methods which are either now developed or which will be developed in the future over the next several years becomes a practicality, that you would then be in a position to come to Congress and say, as a result of coordinating and correlating all available information, that you could now be in a position to come and say to Congress, "We would now be in a position to build a demonstration plant using this method"—and specifying what it is.

Mr. BENNETT. I believe there is a great need for that coordination. There is a question, as Mr. Engle brought out, what you could get out of the private firms.

You could probably get it out of the universities; they are many times financed with what amounts to public funds, and their work is public to that extent.

Private firms, I think, however, would stymie to a considerable extent the full effect to be accomplished by the substitute bill. You just could not get the information from them to pass on to similar firms or industries to prevent them or keep them from duplicating work.

There is that draw-back but there is at the same time a need for that coordination.

There is another very important point, if I may be so bold as to bring it out, that I think perhaps you have overlooked. These institutions and private firms particularly, need help. They need the incentive factor, and they do need financial assistance.

Mr. BENTSEN. It has not been overlooked; that was the very point I brought up, when I said you were practically eliminating the assistance on research by cutting it to $50,000.

If I may interrupt: Mr. Bow, I understand that your amendment does allow for the contracting of physicists and chemists and engineers and so on, for research?

Mr. BOW. That is correct.

Mr. BENTSEN. I think that Mr. Bow has brought out an excellent point, as have Mr. Bennett and Mr. Saylor, on this question of the timing of the pilot plant.

I do not think we have reached that point yet.

Now, I think this substitute bill has considerable merit to it, but this is, in fact, a terrific problem, with immense potentialities of great interest to the Nation, and with many probable benefits, and I think that the $50,000 cuts it down to the point where we could not assist with the research and hurry the day when we would reach the point where it would be possible to say that it would be feasible to operate a pilot plant.

Therefore on page 5, line 3, I would like to offer an amendment to change the sum of $50,000 to $2,000,000, as in the Senate bill.

Mr. D'EWART. Would the gentleman yield?

Mr. BENTSEN. Yes.

Mr. D'EWART. You would not say that the Southwest Research Institute needed any financing from the Federal Government; would you?

Mr. BENTSEN. Yes, I would say it did; and I happen to know it very well. My father is a trustee.

Mr. D'EWART. Doesn't it get funds from a rich oil company?

Mr. BENTSEN. I happen to know that rich oil company very well, and I know the funds it puts into it, and I know those funds go for various purposes and endeavors.

For instance, among other things, they are experimenting there on the breeding of cattle by artificial insemination, whereby they put the cow and the bull serum together, and so get a scrub cow to produce fine, purebred calves.

That is just one instance. They have spread their efforts over a great field, and the rich oil company has really not put an awful lot of money into the deal; my good friend, John Slick, has donated the money to charitable organization, and they are doing a fine work; but the amount they can spend on this work is quite limited.

Mr. MILLER. Will the gentleman yield?

Mr. BENTSEN. I yield.

Mr. MILLER. In regard to this $50,000, which you are suggesting should become $2,000,000, the Senate bill is $2,000,000 for a period of 5 years.

Mr. BENTSEN. How does your bill read, Mr. Bow?

Mr. BOW. My bill was $50,000 a year.

Mr. BENTSEN. It does? Does it really do that?

Mr. BOW. I don't think my bill is clear on that and should be clarified.

Mr. BENTSEN. It does not really say $50,000 a year, if I remember your amendment.

Mr. BOW. You are correct.

Mr. BENTSEN. If it were $50,000 from time to time as necessary for that act, it would reflect a $50,000 appropriation.

Mr. BOW. Right.

Mr. BENTSEN. I would like to make that a flat $2,000,000 appropriation, and that would carry until such time as we needed more, which might be 5, 10 or 20 years; we could reexamine at a later time.

Mr. BOW. Would the gentleman yield?

Mr. BENTSEN. Yes.

Mr. BOW. Would the gentleman give reconsideration to a certain portion of it being for the use of research in other institutions and limiting the amount to be used for coordination and correlation in the Department?

By taking whatever that amount would be, we could determine it will be used for that purpose.

Mr. BENTSEN. I think that has considerable merit. I think it is a good idea.

Mr. ENGLE. Mr. Bennett, do you have something to say in addition?

Mr. BENNETT. No, I am through.

Mr. ENGLE. Mr. Crawford.

Mr. CRAWFORD. Mr. Bennett, first may I say this. The enormous activity in this general field shows that there are a lot of people interested, and I think when we consider the historical background of our industrial development it has reached the point where the chances are the necessary funds for people will be provided by the enterprise; that would be my guess.

Secondly, you stated a few minutes ago, if I understood you correctly, a lot of these people needed some financial assistance.

If they want that assistance, why are they not here asking for it so that we can face them on cross-examination and find out how much

money they want taken out of the Treasury today to spend for this kind of work?

Mr. BENNETT. I cannot answer that directly, sir, but I can tell you that many of them appeared before the Senate committee when the Senate held hearings.

Mr. CRAWFORD. Can you name some of those who appeared there?

Mr. BENNETT. Offhand, I could not name any; but I could get it from the record.

Mr. CRAWFORD. I think we ought to have that information, because we have every firm and business coming in to us and asking, "Why in blank blank don't you fellows cut these expenses and stop pouring money out of the Federal Treasury," and on the basis of those representations, I am not sold on this bill at all, even for the $50,000 a year which I believe is proposed—and here is why:

If you are going to go out here to assist these people, who is going to make the decision as to who gets how much money?

Will you answer that for us. Suppose this bill is giving you $20,000,000 or $2,000,000, who is going to make the decision who gets the money?

Mr. BENNETT. The way the bill was originally written, that decision would be with the Secretary of the Interior.

Mr. CRAWFORD. So he picks anybody he pleases?

Mr. BENNETT. He would have advice from the staff, of course.

Mr. CRAWFORD. But he could make the decision, of course?

Mr. BENNETT. That is right.

Mr. CRAWFORD. And nobody could question it?

Mr. BENNETT. Well, they couldn't change it.

Mr. CRAWFORD. That is right.

Mr. BENNETT. The full responsibility is on him.

Mr. CRAWFORD. Mr. X, on the basis of all the facts, is making very substantial progress, and Mr. G, out here is not making too much progress, but he has first call on the Secretary of the Interior through the advisers of the Secretary.

What are you going to do with a sitiation like that?

Mr. BENNETT. That is very difficult to answer.

Mr. CRAWFORD. Sure it is difficult to answer—and the chances are you would get into rank discrimination.

Let us get on to the next one. It is submitted that no one knows which of these formulas to pick up at the present time and proceed with.

Why not let this thing go a little further along?

My final point is this.

If this job is what it appears to be, what can you do with $2,000,000? What can you do with $2,000,000? Why, you can go along and string this thing out for 5, 10, or 15 years, and have a nice little organization getting along pretty well on the dollars supplied by the taxpayers, with no substantial accomplishment.

My experience with some of these things in a private way is that the board decides to spend the money for so-and-so, and then says, "Let's spend whatever money is necessary to get the job done. If we haven't any confidence it can be done, we don't vote for the project; but if we do have confidence in it, we put up the funds on the barrel head, get the scientific minds, and do the job."

Those are some of the thoughts that are running through my mind and I am not sold on the $2,000,000 a year whatever, because that is the sum Mr. Bentsen proposes, and I understand his proposal is to give aid to some of these people. Is that right?

Mr. BENTSEN. I think it should be limited to public research institutions such as MIT, and that sort of thing.

Mr Crawford, on that point, I have a change on the amendment which I would like to bring up for your consideration and that of the rest of the committee.

Mr. BENTSEN. May I have unanimous consent to withdraw my amendment?

Mr. ENGLE. Without objection, the amendment proposed by Mr. Bentsen is withdrawn.

Mr. BENTSEN. I would like to substitute the figures "$1,000,000" on line 3, page 5; and on line 5, after the word "Act," strike the period and follow with this language:

Provided, That the departmental expenses for the correlation and coordination of information each year shall not exceed—

no, that is wrong; strike that.

Provided, That departmental expenses for the accumulation and coordination of information over a 5-year period shall not exceed the sum of $250,000.

Mr. CRAWFORD. That would leave you——

Mr. BENTSEN. That would leave you $750,000 to assist in research.

Mr. CRAWFORD. Of a million dollars a year?

Mr. BOW. You suggest $1,000,000 and limit the Department to $50,000 a year. The balance would be used for institutions?

Mr. BENTSEN. That amendment still needs some clarification.

You would have to limit that to coincide with the Senate bill—limit that million dollars to 5 years, and in the wording I stated we only limited the $250,000; so would you draft that amendment right away for us, to limit the million dollars to 5 years and not over $250,000 of it shall be spent within the Department for the accumulation and coordination of information within the 5-year period.

Mr. HARRISON. Does the gentleman yield?

Mr. BENTSEN. Yes.

Mr. HARRISON. Doesn't the wording put in there allow the Department to spend the whole $250,000 in 1 year, or spend any portion of it in any 1 year that they wanted?

Mr. BENTSEN. Well, they wouldn't have anything to spend on the next four; except for poor management,——

Mr. HARRISON. I think it should be written so the Interior Department could not spend more than $50,000 in any 1-year period.

Mr. BENTSEN. It would spend the $250,000 over a 5-year period.

Mr. HARRISON. I would hate to see it, but what would happen if they came and said, "We are faced with a grave situation; we have spent our money in order to keep this good work going; we must have additional money."

Mr. BENTSEN. We could put a provision in there that will call for the equal spending of the $250,000 over the 5-year period.

Mr. CRAWFORD. Will the gentleman yield?

Mr. HARRISON. Yes.

Mr. CRAWFORD. Let us go back to Mr. Bow's original proposition—$50,000 a year.

Mr. BOW. That is what I intended.

Mr. CRAWFORD. If you tied into that $50,000 a year concept a program which could be handled on $50,000 a year—in other words, if you put it there having in mind the salaries of a little staff to do certain work, which $50,000 a year will cover—on that basis you would be financing the undertaking.

But if you give them $50,000 and indicate that you expect from them a vast amount of work which they cannot possibly do, you are not accomplishing very much.

In other words, the $50,000 is not sufficient appropriation for the job you want done.

Now, I do not think a million dollars is going to do so very much on this thing. It will tease some operations around and maybe encourage two or three fellows who happen to obtain the windfall but it may discourage some of these other fellows on the ground that they have no encouragement from the Government in the way of cash benefits.

Mr. BENTSEN. Will the gentleman yield?

Mr. CRAWFORD. Yes.

Mr. BENTSEN. It would seem to me that some of your public organizations such as M. I. T., or Southwestern Institute, if it can be considered as such, might have a budget set up for this particular purpose, perhaps $50,000—let us use an arbitrary figure. And if they could look upon another $50,000, say, being granted for that research and if they were given that in consideration of the information and data going back to the public for that charge, it would encourage them to delve farther in the field. They would be able to accomplish more research with less expenditure of their own money than in some other field and perhaps the doubling of funds that they spend for that purpose might actually lead to a solution of the problem.

Mr. CRAWFORD. What is there in this proposed legislation as it is now before us which will be an obligation upon the recipients of whatever benefits may happen to flow from the Federal Treasury, to hand back to the Government, for the benefit of the public, whatever findings they may make?

What is there in this proposal to that end?

Mr. BENTSEN. It seems to me that we have to have some confidence in the business judgment of whoever administers it. I think that it would be a breach of faith, responsibility and all good judgment if whoever administered the allocation of this research fund were to give it to some one who was not under obligation to make it public information.

Mr. CRAWFORD. We will take a specific instance, then. Let us consider what happened in the case of the Virgin Islands Corporation, which is an entirely Government-owned proposition, manufacturing rum, which made a sales contract with a certain operator up in New York City, I believe it was, and a trade-mark was developed, "Virgin Islands Rum."

We have had this case running for years as to who owns the trademark—and that was handled by the Department of the Interior.

I am not making any back charges against the Department of the Interior, because I try to work closely with them. But if you want to vote for a provision, I am getting pretty technical on this stuff—

I don't mind saying that. Put down in black and white exactly what you want me to support, so I will know what to do.

Now, here is an agreement of interested parties, and if 15 fellows go out and substantially contribute their private funds to the proposition and the Government comes along and gives them a half a million dollars, or $250,000, how are you going to protect the public interest in that case?

Mr. ENGLE. You are going to have to insist that if public funds are used in research, the public will have available to it the findings of the research resulting from the expenditure of these public funds.

Mr. CRAWFORD. Where the major portions of the funds are put up by private enterprises, what kind of provisions are you going to put in this law to show that the private enterprises will not be able to walk away with this thing under the provisions of the law if they share in this work. After all, we have got some smart lawyers in this country.

Mr. ENGLE. I think we may say, Mr. Crawford, if public funds are going to be made available, any benefits derived from the research where public funds are used must be made available, must be made public.

Mr. BENTSEN. All right. Let us see if we can work something out that would put it in the bill.

Mr. MILLER. It should be put in the report, I believe, rather than in the bill itself.

Mr. BENTSEN. How about putting it in the report, Mr. Crawford. I think that would safeguard it, and it would not clutter up the bill.

Mr. MILLER. I want to offer this suggestion, too. I question very much the advisability of making funds available at this time for some of these institutions, because without funds they have proceeded here, 15 or 20 of them, to make great strides in this field.

If they were to get a little dab of public funds, it might be very hard to administer. It might be a bit of a stimulus, but here in 2 or 3 years they have made all the progress they have made, and recently MIT have said that they can make potable water out of salt water at very reasonable cost.

So I wonder why this should be done, or whether the appropriation of any small amount of money to carry on research will be of material benefit, because they have just started, and I dare say if they continue as they have, the parties engaged in this work will come up with the answer in 2 or 3 years without any public funds being expended.

Mr. BENTSEN. Will the gentleman yield?

Mr. MILLER. Yes.

Mr. BENTSEN. Of course that is a viewpoint that has some merit to it. I personally am of the opinion that this may provide a stimulus to research which is of great interest to the general public and the Nation and that it might hasten the arrival of a satisfactory solution.

In order to save the time of the committee so that we can get to this amendment once again, I would like to withdraw the amendment, Mr. Chairman, and introduce a clean amendment that I think meets some of the gentlemen's objections, if I may.

Mr. ENGLE. Are you prepared now to offer such an amendment?

Mr. BENTSEN. Yes; Mr. Chairman. I think we are prepared now to meet most of the objections which have been offered.

May I have unanimous consent to withdraw the amendment which I previously offered?

Mr. ENGLE. Mr. Bentsen has unanimous consent to withdraw the amendment previously offered, in order to offer a clean amendment.

Without objection, so ordered.

Mr. BENTSEN. And I apologize for the delay and confusion, but I think it is necessary, and I believe this will meet some of the objections.

So now we will start. The amendment will be on page 5.

Mr. D'EWART. Of the Bow substitute?

Mr. BENTSEN. Yes. On page 5, line 1, section 7.

There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $1,000,000 for a 5-year period to carry out the provisions of this act: *Provided*, That departmental expenses for the correlation and coordination of information over a 5-year period shall not exceed the sum of $250,000, *And provided further*, That departmental costs shall be scheduled in equal amounts over that period insofar as practicable.

That is the clean amendment. I think it meets some of the objections that have been offered, though perhaps it does not meet all of them.

I would further say the suggestion Mr. Crawford has is an excellent one and possibly would be solved by Mr. Miller's suggestion that it be incorporated in the report.

Mr. ENGLE. To get everything technically correct, you have stricken everything after section 7, and inserted your amendment?

Mr. BENTSEN. Everything after the numeral 7, in line 1, and started where the words start. We have inserted that new phraseology at that point.

And that is an amendment to the Bow substitute.

Mr. MILLER. Inasmuch as this substitute is really a new bill with amendments added to it, I am wondering if it would not be the part of wisdom for the chairman to order a new committee print of the bill before we considered final action.

I do not insist upon it but I am wondering if that would not clarify the situation before us.

Mr. ENGLE. I think we know what we are doing, so long as we are not so confused we do not know what we are doing, which is often the case—but in this instance Mr. Bow has made very clear what he has done.

Mr. BENTSEN. And I hope that I have finally made it clear, also.

Mr. ENGLE. We are not running into any difficulty on that. We may run into difficulty on another part of the language, but on section 7 we certainly know what we are doing.

Mr. POULSON. Will that be section 7 in the Bow amendment?

Mr. BENTSEN. Yes.

Mr. ENGLE. Would you care to say something?

Mr. BENTSEN. No; I think this has been pretty well clarified.

Mr. ENGLE. Is there any further discussion on the Bentsen amendment to the Bow substitute?

Mr. SAYLOR. Yes. The statement in the report.

Mr. ENGLE. May I ask, if in the administration of the act the Secretary, in the contracting out of this money, shall make provision in the contract that the results of the research due to the expenditure of public funds shall be open to public use—will that, in your judg-

ment, meet the situation we should have in mind? I wonder if that would take care of it? I am sure if that were plainly in the report, the Secretary would follow that directive, and not only that, I am pretty sure he would do it anyway, even if it were not in the report.

Mr. CRAWFORD. I would like to ask one question: Where is the language in the bill now before us which limits the assistance extended by the Department of the Interior to nonprivately financed undertakings?

Mr. ENGLE. It does not do it, because if you require the results of the research due to the expenditure to be made public, whether it is done by private or public institutions, it has the same beneficial effect.

In other words, it may be advantageous to contract with Ionics, Inc. I am not saying they would want to do that—but assuming they came along and said, "We are going to have to go a little further here and we are willing to make our research a matter of public information if this additional money is made available," there is no reason why that might not be done, because they may be getting along further than some university.

Are you ready for the question on the Bentsen amendment? Do you understand what it does? Are you ready for the question?

Mr. BUDGE. Mr. Chairman, it seems to me, since we have the witnesses from the Department available, it might be wise to see if they feel they could carry on the program under this provision.

Mr. BENTSEN. I think Mr. Bennett dealt with that point in his testimony.

Mr. ENGLE. The gentleman from Florida.

Mr. MCMULLEN. It seems to me that this amount is too little and too late. I think this is just about as important a question as we will have to pass on in a long time. In other words, the appropriation of $1,000,000 to do a job like this is almost like not tackling the job at all; it is like sending a boy to do a man's work.

I would like to see this bill say $20,000,000, just as it did in the original bill, where it provides that the amount to be appropriated is $20,000,000 as the Congress may from time to time determine and deem necessary to carry out the provisions of the act.

It would seem to me that provides all of the safeguards we need to protect the public funds. I think this thing is of such tremendous importance to our nation that we must help it move forward in every way we can, and in my opinion, $1,000,000 is not going to do the job.

Mr. BENTSEN. Will the gentleman yield?

Mr. MCMULLEN. Yes.

Mr. BENTSEN. I am somewhat of the same sentiment, but I am in the position of realizing the sentiment of Congress at this time and I would rather get a boy out there than have no one at all.

That is why I am myself in this position.

Mr. ENGLE. I saw the figures submitted by Ionics, Inc. It seems to me their figures showed expenditures of $143,000 to date. It did a good deal to deflate my ideas about how much money was necessary to advance research.

If you get into a demonstration plant, you have a different problem. If you go into a demonstration plant, you are going to start spending more money.

Research is not so expensive because it involves mainly the employment of technicians.

I agree with the gentleman from Florida, and also with Mr. Bentsen when he says it is going to be hard to get an appropriation through this Congress, and that it is better to get a little bit than none at all—and I think maybe a lot can be done with what we have, provided it is used in the manner prescribed.

Now, those in favor of the Bentsen amendment to the Bow substitute will vote "aye," those opposed vote "no."

The "ayes" have it and the amendment is adopted.

Now are you ready for the question on the Bow substitute?

Does everyone understand the Bow substitute as amended?

It now eliminates the pilot plant and provides for the spending of of $1,000,000 in the manner prescribed.

Those in favor of adopting the Bow substitute as amended say "aye," those opposed, "no."

The "ayes" have it and the Bow substitute is adopted as amended.

Now the question before the committee is on H. R. 6578 as amended by the Bow substitute as amended.

Those in favor will say "aye," those opposed will say "no."

The ayes have it, and H. R. 6578 is favorably reported as amended.

Now, did someone wish to suggest a clean bill?

Mr. McMULLEN. Before you get into that I want to make a statement on why I voted "no." I think the fund is entirely too small; I do not think it is commensurate with the importance of a project of this nature to our Nation, as envisaged in the Bow substitute, and I would personally prefer to see some department or agency of the Government perfect this formula rather than have some private industry do it.

Mr. MORRIS. Mr. Chairman, I would like to make a statement for the record at this time.

I fully agree with the gentleman from Florida; I think the fund is far too small. I voted for the substitute and for the amendment for the reason that I see at this time that it is the only practical way to move this legislation along. At least that is the way I felt about it, and certainly it is better to have half a loaf than none at all.

But I think that this particular subject which we are here dealing with is of transcendent importance to our great nation and to the world, and I think the fund provided is far too small.

Mr. MILLER. Now may I make a parliamentary inquiry on the new bill introduced.

I think it will get us into less trouble on the floor if we do have a new bill as amended—a new bill brought in, instead of suggesting amendments on the floor of the House.

I would like to suggest that a new clean bill be introduced.

Mr. SAYLOR. Mr. Chairman, I move that——

Mr. ENGLE. Let us keep the record clear at this point.

Several members of the committee have stated their positions and the chairman would like to state his at this time. The chairman would like to associate himself with the remarks made by the gentleman from Oklahoma, Mr. Morris, and the remarks of the gentleman from Florida, Mr. McMullen.

I, too, think that this is a matter of transcendent importance. If the results of this type of experimentation are realized and the commercial possibilities developed so that it is possible to produce potable

water on an economic basis, it will revolutionize the industry and economy and the future of not only the coastal areas of this country and the arid regions of the West, and the regions of the United States now short of water, but also, in addition to that, it could very easily revolutionize the economic situation in large areas of the world.

There is no field in which our Government should be more alert than in the field of research. The Germans demonstrated in the last war what they could do because of research, when that small nation, devoid of major resources, held three major powers of the earth at bay for 5 years just on the basis of advancements they had made in the field of research and in the field of scientific development and its application to industry.

This is a tremendously important field and I hope we are not sending a boy to do a man's job, but we are going to try to legislate so as to do the thing which is feasible at this time, the thing that is legislatively and politically feasible, so that we can get started on it.

Mr. Miller has raised the question of a clean bill. Let us go off the record for a moment.

Mr. D'EWART. I would like to say on the record that the committee has made a real forward step in voting out the bill and it is moving toward the accomplishment of the very objectives we are talking about.

This bill does provide $1,000,000 to coordinate the work being done by private industry and private institutions, and public institutions, and if it does that we will have made a real advance towards the accomplishment of our objectives.

Mr. SAYLOR. I would like to concur in the statement of Mr. D'Ewart.

Mr. ENGLE. I agree with you gentlemen that we are going forward, but I hope we are not creeping, but running.

Now let us go off the record.

(Discussion off the record.)

Mr. ENGLE. Without objection, the previous action of the committee in adopting the Bow substitute as amended will be vacated, and the Bow substitute and all after the enacting clause in H. R. 6578 will be considered as stricken, and the Bow substitute as amended will be substituted.

Is there objection?

Mr. SAYLOR. And the title amended.

Mr. ENGLE. Yes, of course; the title amended as indicated by the gentleman at the time he submitted his substitute.

Is there objection?

Without objection, that will be the order of the chair and the action of the committee.

And without objection, the bill will be considered reported as voted out with the Bow substitute as amended, substituted under the title, with the title amended.

If there is no objection, that will be the order of the Chair and we will move on to further business.

(Whereupon, at 11:35 a. m., the committee proceeded to further business.)

(Copy of H. R. 6578 as reported to the House is as follows:)

[H. R. 6578, 82d Cong., 2d sess.]

A BILL To provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, [That in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of economically feasible means of producing from sea water, or other saline waters, water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized to construct, maintain, and operate facilities (including not more than one demonstration plan) to determine and to demonstrate the feasibility of producing water as aforesaid; for purifying and storing the water and byproducts derived from the operation of such facilities. Facilities constructed and operations undertaken pursuant to this Act shall be on a scale sufficient to determine the feasibility of the development of such production on a large-scale basis, for the purpose of conserving and increasing the water resources of the Nation.]

[SEC. 2. In order to carry out the purpose of this Act, the Secretary of the Interior is authorized—

[(a) to conduct development work, which shall be limited to that work directly connected with the operation of a demonstration plant by the Interior Department and appurtenant facilities, to ascertain the lowest investment and operation costs, and to determine the best plant designs and conditions of operation;

[(b) to engage, by contract, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work; to coordinate the study of methods for the recovery and marketing of byproducts resulting from and incident to the production of water as herein provided for the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

[(c) to acquire, by purchase, license, lease, or donation, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided,* That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

[(d) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act;

[(e) to request other Federal departments, agencies, and instrumentalities to provide assistance in carrying out his functions under this Act, which assistance such departments, agencies, and instrumentalities are hereby authorized to render, and to advance to them funds required to render such assistance or to reimburse them for costs incurred in so doing.]

[SEC. 3. The Secretary of the Interior is authorized to dispose of all water and other products produced as a result of its operations under this Act pursuant to regulations to be prescribed by him: *Provided,* No patent acquired by the United States under this Act shall prevent any citizen of the United States, or corporation created under the laws of the United States or any State thereof, from using any invention, discovery, or process covered by such patent, or restrict such use by any such citizen or corporation, or be the basis of any claim against any such person or corporation on account of such use.]

[SEC. 4. All moneys received for products of the plants and for royalties and licenses under this Act shall be paid into the Treasury as miscellaneous receipts.]

[SEC. 5. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The reports shall include suitable recommendations for further legislation.]

[SEC. 6. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.]

[SEC. 7. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $20,000,000, as

the Congress may from time to time deem necessary to carry out the provisions of this Act.]

That in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of economically feasible means of producing from sea water, or other saline waters, water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized—

(a) to supervise and direct the correlation and coordination of research and development work, which shall be limited to that work directly necessary to the development of one or more practical processes, to ascertain the lowest investment and operation costs, and to determine the best plant designs and conditions of operation;

(b) to engage by contract, for the purposes outlined in subsection (a), chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work; to correlate and coordinate, to the extent appropriate, the research and development work in this field being made by such educational institution, scientific organization, or industrial or engineering firm;

(c) to acquire, by purchase, license, lease, or donation, technical data, inventions, patent applications, patents and licenses, to be made available to such chemists, physicists, engineers, educational institution, scientific organization or industrial or engineering firm engaged in any part of the research or other work;

(d) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act; and

(e) to request other Federal departments, agencies, and instrumentalities to provide assistance in carrying out his functions under this Act, which assistance such departments, agencies, and instrumentalities are hereby authorized to render, and to advance to them funds required to render such assistance or to reimburse them for costs incurred in so doing.

SEC. 2. The Secretary of the Interior is authorized to dispose of all water and other products produced as a result of its operations under this Act pursuant to regulations to be prescribed by him: Provided, That no patent acquired by the United States under this Act shall prevent any citizen of the United States, or corporation created under the laws of the United States or any State thereof, from using any invention, discovery, or process covered by such patent, or restrict such use by any such citizen or corporation, or be the basis of any claim against any such person or corporation on account of such use.

SEC. 3. All moneys received for products of the plants and for royalties and licenses under this Act shall be paid into the Treasury as miscellaneous receipts.

SEC. 4. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The reports shall include suitable recommendations for further legislation.

SEC. 5. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.

SEC. 6. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $1,000,000, for a five-year period, to carry out the provisions of this Act: Provided, That departmental expenses for the correlation and coordination of information over said five-year period shall not exceed the sum of $250,000: Provided further, That departmental costs shall be scheduled in equal amounts over that period insofar as practicable.

Amend the title so as to read: "A bill to provide for correlation and coordination of research into practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes."

(Copy of House Report 1519 on reported bill is as follows:)

[H. Rept. No. 1519, 82d Cong., 2d sess.]

The Committee on Interior and Insular Affairs, to whom was referred the bill (H. R. 6578) to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and

for other purposes, having considered the same, report favorably thereon with amendments and recommend that the bill, as amended, do pass.

The amendments are as follows:

Strike all after the enacting clause and insert in lieu thereof the following:

"That in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of economically feasible means of producing from sea water, or other saline waters, water of quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses. To this end, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized—

"(a) to supervise and direct the correlation and coordination of research and development work, which shall be limited to that work directly necessary to the development of one or more practical processes, to ascertain the lowest investment and operation costs, and to determine the best plant designs and conditions of operation;

"(b) to engage by contract, for the purposes outlined in subsection (a), chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work; to correlate and coordinate, to the extent appropriate, the research and development work in this field being made by such educational institution, scientific organization, or industrial or engineering firm;

"(c) to acquire by purchase, license, lease, or donation, technical data, inventions, patent applications, patents and licenses, to be made available to such chemists, physicists, engineers, educational institution, scientific organization or industrial or engineering firm engaged in any part of the research or other work;

"(d) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act;

"(e) to request other Federal departments, agencies, and instrumentalities to provide assistance in carrying out his functions under this Act, which assistance such departments, agencies, and instrumentalities are hereby authorized to render, and to advance to them funds required to render such assistance or to reimburse them for costs incurred in so doing.

"SEC. 2. The Secretary of the Interior is authorized to dispose of all water and other products produced as a result of its operations under this Act pursuant to regulations to be prescribed by him: *Provided*, No patent acquired by the United States under this Act shall prevent any citizen of the United States, or corporation created under the laws of the United States or any State thereof, from using any invention, discovery, or process covered by such patent, or restrict such use by any such citizen or corporation, or be the basis of any claim against any such person or corporation on account of such use.

"SEC. 3. All moneys received for products of the plants and for royalties and licenses under this Act shall be paid into the Treasury as miscellaneous receipts.

"SEC. 4. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The reports shall include suitable recommendations for further legislation.

"SEC. 5. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.

"SEC. 6. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed one million dollars, for a five-year period, to carry out the provisions of this Act: *Provided*, That departmental expenses for the correlation and coordination of information over said five-year period shall not exceed the sum of $250,000: *Provided further*, That departmental costs shall be scheduled in equal amounts over that period insofar as practicable."

Amend the title to read:

"A bill to provide for correlation and coordination of research into practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes."

PURPOSE OF THE BILL

H. R. 6578 was introduced in order to have a "clean bill" containing the numerous amendments to H. R. 7 made by the Subcommittee on Irrigation and

Reclamation of the Committee on Interior and Insular Affairs in the first session of the Eighty-second Congress. The Committee on Interior and Insular Affairs made even more drastic changes in the bill at its meeting on March 11, 1952. The basic objective of the bills is the same; namely, to authorize research in the field of desalting sea water and saline water in an effort to provide additional sources of fresh water in areas of scarcity.

The more specific purpose of language contained in the new bill (H. R. 6578, as amended) is to prevent any unnecessary authorization of more Government activity where results can be obtained by use of private or non-Federal funds. It is the opinion of the committee that Federal activity should be confined to the bare minimum necessary to carry out the provisions of this bill. This legislation would place definite limitations on the Department of the Interior and confine the Department's functions regarding this subject to correlating data and coordinating progress in research.

Because of the proposed research program's relation to furnishing additional water for arid areas, presumably the work contemplated can be carried on within the Interior Department's Bureau of Reclamation. This, the committee believes, should make unnecessary the creation of any additional organization within the Department to carry out the purposes of H. R. 6578.

The bill carries an authorization for an appropriation of $1,000,000 for a 5-year period and provides that departmental expenses for the correlation and coordination of information over said 5-year period shall not exceed $250,000 scheduled in equal amounts each year, insofar as practicable.

It is the intent of the Committee on Interior and Insular Affairs that the Secretary of the Interior shall include a provision which requires that the results of the research conducted with the aid of public funds shall be available at all times for general public use in any contracts which are entered into as a result of this act.

EXPLANATION OF THE BILL

Section 1 declares it to be the policy of the Congress to provide for the development of economically feasible means of producing from sea water, or other saline waters, water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground water throughout the Nation.

Section 1 (a) authorizes the Secretary of the Interior to correlate and coordinate research and development work to ascertain the lowest investments and operation costs, and to determine the best plant designs and condition of operation.

Section 1 (b) authorizes the Secretary to engage by contract, for the purposes outlined in subsection 1 (a), chemists, physicists, engineers, and other persons; also, any educational institution, scientific organization, or industrial or engineering firm to conduct research and development work.

Section 1 (c) provides for the acquisition by purchase, license, lease or donation, any technical data, inventions, patent applications, patents and licenses, to be used in carrying out the provisions of this act.

Section 1 (d) provides for cooperation with non-Federal public agencies, private individuals, and other groups to effectuate the purposes of this act.

Section 1 (e) authorizes the Secretary to request assistance from other Federal agencies and makes provision for the transfer of funds.

Section 2 provides for the disposal of water and byproducts of the research program, and also protects the right to full public use of the patents or discoveries made as a result of this act.

Section 3 provides for deposit of moneys collected from the sale of water or byproducts of the research program.

Section 4 requires annual reports on the program to the President and the Congress from the Secretary of the Interior.

Section 5 provides for issuance of departmental rules and regulations to carry out the purposes of the act.

Section 6 authorizes the appropriation of funds with definite restrictions on departmental costs in the research program.

The Committee on Interior and Insular Affairs recommends the enactment of H. R. 6578.

DEPARTMENT REPORTS

The favorable comments on H. R. 6578 from the Secretary of the Interior dated March 7, 1952, are set forth below. These supplement the Department's report of April 10, 1951, on the original bills, H. R. 6 and H. R. 7, which is also included.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., March 7, 1952.

Hon. JOHN R. MURDOCK,
Chairman, Committee on Interior and Insular Affairs,
House of Representatives, Washington, D. C.

MY DEAR MR. MURDOCK: In response to your recent requests for reports from this Department on H. R. 6578 and H. R. 6704, both of which are bills to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes, I enclose copies of a letter dated February 25 to the Honorable Clair Engle, chairman of the Subcommittee on Irrigation and Reclamation, which was sent in reply to a letter from him dated February 18.

The letter to Mr. Engle contains a statement of the views of this Department on H. R. 6578 with which H. R. 6704 is identical. It has been sent to the Bureau of the Budget and will, I hope, serve your committee in lieu of a formal report on these two bills.

As is pointed out in the letter to Mr. Engle, our examination of H. R. 6578 indicates that the general principles of this legislation are the same as H. R. 7 with respect to the latter's salt-water aspects. In reporting to your committee on this bill on April 10, 1951, we indicated that the Bureau of the Budget had advised that its enactment would be in accord with the program of the President.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., February 25, 1952.

Hon. CLAIR ENGLE,
Chairman, Subcommittee on Irrigation and Reclamation,
Committee on Interior and Insular Affairs,
House of Representatives, Washington 25, D. C.

MY DEAR MR. ENGLE: Thank you for your letter of February 18 in which you invited me to comment on H. R. 6578, a bill to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

Mr. Lineweaver, of the Bureau of Reclamation, has told me of your conversation with him concerning this matter. I had hoped, of course, that the committee would see fit to report out one of the bills that had previously been introduced and that had been cleared with the Bureau of the Budget. I believe, however, that your conclusion that the general principles of this legislation are the same as H. R. 7, which has already been approved by the Bureau of the Budget is well founded with respect to the salt-water aspects of H. R. 7 to which H. R. 6578 is limited. Although I have had no discussion with Bureau of the Budget officials concerning H. R. 6578, our own examination of this bill would lead us to much the same conclusion. Even with the reduced amount of appropriations which the bill authorizes—an amount which, I assume, can be increased at some later date if the need arises—its enactment would go far toward permitting active Federal civilian participation in the very important program which it envisages.

Please call on us if we can be of any further assistance to you in this matter.

Sincerely yours,

OSCAR CHAPMAN, *Secretary of the Interior.*

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington 25, D. C., April 10, 1951.

Hon. JOHN R. MURDOCK,
Chairman, Committee on Interior and Insular Affairs,
House of Representatives, Washington, D. C.

MY DEAR MR. MURDOCK: I am glad to comply with your requests for an expression of the views of this Department on two identical bills (H. R. 6 and H. R. 7) to provide for research into and demonstration of practical means for the economical production, from sea or other saline waters or from the atmosphere (including cloud formations), of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes.

H. R. 6 and H. R. 7 are based upon several previous bills and amendments thereto. These include S. 1300 and H. R. 3123, Eighty-first Congress, which were introduced by Senator O'Mahoney and Congressman McKinnon, respectively; the amendments to S. 1300 proposed on January 5, 1950, by Senator Downey for himself and Senators O'Mahoney and McFarland, and the amendments recommended by this Department in its reports of July 7, 1949, April 12, 1950, and June 23, 1950, to the Senate Committee on Interior and Insular Affairs and in its report of April 12, 1950, to the House Committee on Public Lands. Reference is invited to those reports for certain details not herein discussed.

Enactment of H. R. 6 or H. R. 7 would authorize this Department to engage in necessary research to develop economically feasible means of producing from saline waters directly or from the atmosphere water which is suitable for beneficial consumptive use.

Water shortages are acute throughout many areas of the West today, where many thousands of acres of irrigated land are being kept in production only through serious overpumping of the existing ground water. Pumping from ground water for irrigation in some of the most highly productive areas in California, Arizona, and New Mexico, during the past few years has been at rates far exceeding the safe yields as estimated by the United States Geological Survey.

Thousands of acres of fertile western soil await only irrigation water to be transformed into highly productive agricultural lands. With ample water for these lands, opportunities would be presented for expansion of our traditional American farm family way of life, and production of crops to feed and clothe our growing population would be greatly increased.

The fears of drought with its devastation of farm capital and income and its repercussions in commerce and taxation could be ameliorated and perhaps removed all over the United States with discovery of successful ways to obtain precipitation when and where it is needed.

Rapid increases in population in the Los Angeles, San Diego, and San Francisco-Oakland metropolitan areas of California during the 1940's and prospective increases there during the 1950's require an ever-continuing search for water. If the present emergency continues for long, the need for additional domestic and industrial water supplies in these and some of the other western cities may well become immediate and pressing.

Many eastern cities, including New York City, Norfolk, Baltimore, Philadelphia, St. Petersburg, Tampa, Mobile, and New Orleans, as well as midwestern and western cities, are vulnerable to droughts; any sudden increase in the population or industry, such as that which would result from defense preparations or war, would cause serious water shortages in many areas.

Many areas throughout the Western States, because of soil characteristics, have water which is too salty, either originally or because of use and reuse, to be used for irrigation or for industrial and even domestic purposes. Such saltiness is minor compared with the concentrations of ocean water. Such problems can at times be corrected by dilution of the water, or by leaching of soils. But to do so requires an abundance of fresh water generally not available for such purposes.

Man's search for water is the history of the world. The Bible is full of the importance of water to the tribes of Israel. Egypt rose and fell on the flow of the Nile. The Great Plains area of the United States rose to a peak, then came a disastrous slump from lack of water. Man has relied upon wells and the wells dried up; he has tried rivers, and the rivers dried up. Lakes and springs come and go with weather conditions. Few people realize the importance of water in their everyday lives. Water appears to be but an accomplished fact to the average person. But it becomes a fact only as the result of work, research, and vision.

The bills before you are a step forward in man's search. It is a visionary step.

The benefits to millions of our citizens that would follow successful development of economically feasible means of producing, from the oceans and other saline waters, water of quality suitable for beneficial consumptive use would be incalculable. The large-scale purification of the salt water of oceans, either directly in conversion plants or by inducing precipitation of the moisture that nature herself has evaporated from the seas and transported inland, is an opportunity that challenges not only the imagination but the scientific resources of the Nation as well. Frontiers would be opened for development throughout the United States.

Converting salt water to fresh water is an everyday occurrence. Any schoolboy can do it with a teakettle. The problem is how to do it on a large scale at reasonable cost. Already we know that by compression-distillation methods fresh water can be and is being produced for a cost of near $180 per acre-foot. The limiting factor is energy cost. Perhaps use of solar energy is the answer. Numerous other methods have been and should be studied. Some already give promise of water at a reasonable price.

Evidence is also piling up that points to the conclusion that it is possible, under certain conditions not completely defined as yet, to cause some rainfall or snowfall artificially. However, the purpose of governmental research to date has been confined almost entirely to the study of cloud modification. Except for very meager studies by private firms, practical rain-making to increase water supplies has not been an objective of research. I say this notwithstanding the fact that very large segments of our Western States are now undergoing commercial cloud-seeding operations based on very scanty knowledge of the consequences.

From present indications, it appears that the cost of producing rain or snow artificially may be remarkably low once the research and experimental work has been completed. It appears possible that the winter snow pack in certain mountainous areas might be increased in this way. Thus the total quantity of water available for irrigation, municipal water supply, and power production would also be increased. Much basic and applied research and field demonstration, however, will be needed before it can be said with complete certainty on what scale such operations are practicable and what the cost of the resulting product will be.

In addition to the direct benefits that might accrue from increasing the water supply available for beneficial consumptive use, the studies incident thereto may well lead to knowledge which will be useful in controlling or ameliorating air pollution—a serious problem in some areas. The increased runoff from the artificially produced rain or snow may, moreover, require changes in plans for future water-use projects and even in designs of dams and other works. If this additional water is to become available, its amount and location should be determined at the earliest possible date so as to avoid costly alterations of structures now being planned and designed by the Bureau of Reclamation and other Federal and private organizations. It is possible that some modification of existing structures may also be necessary.

The Weather Bureau of the Department of Commerce has for many years engaged in the measurement of atmospheric phenomena, the collection and analysis of precipitation records, and recently in the evaluation of techniques that have been suggested for producing precipitation artificially. The assistance of that agency and of all other organizations which have performed or are conducting research in this field will be sought.

I recommend the deletion of the word "transporting" in line 8, page 2, of the bills.

The committee may wish to consider adding to paragraph (g) of section 2 (p. 4, line 9) a proviso along the following lines: "*Provided*, That prior to conducting any operations in the air the Civil Aeronautics Administration shall be consulted and no such operation which, in the judgment of the Administration, will constitute a hazard to the safety of air traffic within a described area and at a specified time if conducted at a proposed place and time shall be conducted at that place and time."

Your committee may also wish to add a new section between the present sections 2 and 3 reading as follows:

"The Secretary shall, with respect to the development of techniques for the production of water from the atmosphere, cooperate with the Secretary of Commerce to assure that the facilities and experience of the Department of Commerce are fully utilized. Research undertaken by the Secretary under the authority contained in this Act shall be coordinated or conducted jointly with the Department of Defense to the greatest practicable extent compatible with military and security

limitations, to the end that research and developments under this Act which are primarily of a civil nature will contribute to the defense of the Nation and that research and developments in the same field which are primarily of a military nature and are conducted by the Department of Defense will be made available to advance the purposes of this Act and to strengthen the civil economy of the Nation."

We were advised by letter dated March 20, 1950, from the Acting Director of the Bureau of the Budget as follows:

"I am authorized to inform you that the President desires to have the Department of the Interior take the leadership in necessary research, experimentation, and demonstration designed to develop economic means of producing from sea water or other saline waters, water which is suitable for agricultural, industrial, municipal water supply, and other beneficial consumptive uses.

"The President agrees that statutory authority for the necessary work should be sought and requests you to take the lead on behalf of the administration in recommending early enactment by the Congress of S. 1300 with certain amendments * * *."

All of the amendments thereafter suggested were recommended by us to the Public Lands Committee in connection with its consideration of H. R. 3123, Eighty-first Congress, to which reference has already been made, and are incorporated in the text of H. R. 6 and H. R. 7.

I note, moreover, that in his letter of March 16, 1951, to Senator O'Mahoney, the Director of the Bureau of the Budget, after recognizing that "the Departments of the Interior, Agriculture, and Commerce all have responsibilities and programs which may be deeply affected by further developments in weather control and modification," went on to say:

"In the light of information obtained in recent weeks, we feel that it would be appropriate for the several Federal agencies concerned to continue whatever work they can under existing authorities and funds made available under those authorities. We are of the opinion that such further work as can be justified at this time can be carried on under the provisions of S. 5 as suggested for amendment by the Department of the Interior in its report. The authorities of that bill will permit full interdepartmental collaboration.

"Finally, it would seem to this office that further information on attempts to alter weather conditions should be collected from whatever sources are available throughout the country and that such information should be presented to the Congress before legislative authorizations broader than those contemplated in S. 5 are enacted into law."

A copy of Mr. Lawton's letter is attached.

I am advised by the Bureau of the Budget that there is no objection to transmission of this report to the Congress and that enactment of the proposed legislation would be in accord with the program of the President.

Sincerely yours,

OSCAR L. CHAPMAN,
Secretary of the Interior.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington 25, D. C., March 16, 1951.

Hon. JOSEPH C. O'MAHONEY,
Chairman, Senate Committee on Interior and Insular Affairs,
Room 224, Senate Office Building, Washington, D. C.

MY DEAR SENATOR O'MAHONEY: This is in reply to your request of January 11, 1951, for the views of the Bureau of the Budget on S. 5, a bill to provide for the extraction of potable water from sea water and other saline sources, and in further response to a letter of February 26, 1951, from Mills Astin, chief clerk of your committee, in which he asked that we consider S. 5 in relation to two other bills, S. 222 and S. 798, which would provide for the development and regulation of methods of weather modification and control, and of artificially inducing rainfall respectively.

In his 1951 budget message, the President said:

"Experience in recent years has shown that it may not be possible to meet the shortages of water, which are a threat in some areas, through our extensive water resources program. I recommend, therefore, that the Congress enact legislation authorizing the initiating of research to find means of transforming salt water into fresh water in large volumes at economic costs."

As there are no technical obstacles in producing fresh water from the sea and other saline sources, such experimentation should continue, with particular attention to the whole matter of the economic feasibility of the project. Accordingly, it is the view of the Bureau of the Budget that authority should be provided to permit research into methods of extracting potable water from saline sources more economically than is possible under present processes.

On the other aspects of these bills, particularly those relating to the artificial induction of rainfall, and weather modification and control, the picture is by no means as clear. The principal difficulty, as we understand it, appears to be that the physical processes by which rain is formed and precipitated are not yet understood. Some of the foremost scientists in this field doubt whether there is sufficient experimental evidence to prove that precipitation can be successfully induced artificially. In our present state of imperfect knowledge the difficulties of controlling or modifying the weather would seem to be so great that any Federal program should be limited to research and the evaluation of existing knowledge and data. At this time, therefore, it would seem to us unwise, if not impossible, to attempt to settle the jurisdictional questions which the three bills raise. The Departments of the Interior, Agriculture, and Commerce all have responsibilities and programs which may be deeply affected by further developments in weather control and modification. For these reasons the Bureau has indicated that presentation to the committee of their views by all three Departments and any other interested agencies would be without objection from this office.

In the light of information obtained in recent weeks, we feel that it would be appropriate for the several Federal agencies concerned to continue whatever work they can under existing authorities and funds made available under those authorities. We are of the opinion that such further work as can be justified at this time can be carried on under the provisions of S. 5 as suggested for amendment by the Department of the Interior in its report. The authorities of that bill will permit full interdepartmental collaboration.

Finally, it would seem to this office that further information on attempts to alter weather conditions should be collected from whatever sources are available throughout the country and that such information should be presented to the Congress before legislative authorizations broader than those contemplated in S. 5 are enacted into law.

Sincerely yours,

F. J. LAWTON, *Director.*

COMMITTEE NOTE.—On June 30 Representative Clair Engle, author of the measure, on behalf of the Committee on Interior and Insular Affairs, took from the Speaker's table H. R. 6578 for consideration by the House of Representatives. Language originally introduced by Senator Case was substituted in the bill and subsequently approved by the House and Senate. This legislation was signed into law by the President on July 3, 1952 (Public Law 448, 82d Cong.) and is printed below in its entirety.

A BILL To provide for research into and development of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficial consumptive uses, and for other purposes

That, in view of the acute shortage of water in the arid areas of the Nation and elsewhere and the excessive use of underground waters throughout the Nation, it is the policy of the Congress to provide for the development of practicable low-cost means of producing from sea water, or from other saline waters, water of a quality suitable for agricultural, industrial, municipal, and other beneficial consumptive uses on a scale sufficient to determine the feasibility of the development of such production and distribution on a large-scale basis, for the purpose of conserving and increasing the water resources of the Nation.

SEC. 2. In order to carry out the purposes of this Act, the Secretary of the Interior, acting through such agencies of the Department of the Interior as he may deem appropriate, is authorized—

(a) by means of research grants and contracts as set forth in subsection (d) of this section to conduct research and technical development work, to make careful engineering studies to ascertain the lowest investment and operating costs, and to determine the best plant designs and conditions of operation;

(b) to study methods for the recovery and marketing of byproducts resulting from and incident to the production of water as herein provided for

the purpose of ascertaining the possibilities of offsetting the costs of water production in any area by the commercial utilization of such products;

(c) to acquire, by purchase, license, lease, or donation, secret processes, technical data, inventions, patent applications, patents, licenses, land and any interest in land (including water rights, easements, and leasehold interests), plants and facilities, and other property or rights: *Provided*, That the land or other property acquired hereunder shall not exceed that necessary to carry on the experiments and demonstrations for the purposes herein provided;

(d) to engage, by noncompetitive contract or otherwise, chemists, physicists, engineers, and such other personnel as may be deemed necessary, and any educational institution, scientific organization, or industrial or engineering firm deemed suitable to do any part of the research or other work, and to the extent appropriate to correlate and coordinate the research and development work of such educational institutions, scientific organizations and industrial and engineering firms; and

(e) to cooperate with any other Federal, State, or municipal department, agency, or instrumentality, and with any private person, firm, educational institution, or other organization in effectuating the purpose of this Act.

SEC. 3. Research undertaken by the Secretary of the Interior under the authority contained in this Act shall be coordinated or conducted jointly with the Department of Defense to the greatest practicable extent compatible with military and security limitations, to the end that research and developments under this Act which are primarily of a civil nature will contribute to the defense of the Nation and that research and developments in the same field which are primarily of a military nature and are conducted by the Department of Defense will be made available to advance the purposes of this Act and to strengthen the civil economy of the Nation.

SEC. 4. The Secretary of the Interior is authorized, for the sole purpose of this Act, to dispose of all water and other products produced as a result of his operations under this Act pursuant to regulations to be prescribed by him: *Provided*, That nothing in this Act shall be construed to alter existing law with respect to the ownership and control of water.

SEC. 5. All moneys received for products of the plants under this Act shall be paid into the Treasury as miscellaneous receipts.

SEC. 6. The Secretary of the Interior shall make reports to the President and the Congress at the beginning of each regular session of the action taken or instituted by him under the provisions of this Act. The report shall include suitable recommendations for further legislation.

SEC. 7. The Secretary of the Interior may issue rules and regulations to effectuate the purposes of this Act.

SEC. 8. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums, not to exceed $2,000,000, for a five-year period, to carry out the provisions of this Act: *Provided*, That departmental expenses for the correlation and coordination of information over such five-year period shall not exceed the sum of $500,000: *Provided further*, That such departmental expenses shall be scheduled in equal amounts for each year of such period insofar as practicable.

Amend the title so as to read: "A bill to provide for research into and development of practical means for the economical production, from sea or other saline waters, of water suitable for agricultural, industrial, municipal, and other beneficia consumptive uses, and for other purposes."

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